CHARACTERIZATION OF ICHTHYOPLANKTON WITHIN THE U.S. GEOLOGICAL SURVEY'S NORTHEASTERN GULF OF MEXICO STUDY AREA

Based on Analysis of Southeast Area Monitoring and Assessment Program (SEAMAP) Sampling Surveys, 1982-1999

OCS Report USGS-Scientific Investigation Report SIR-2004-5059
(*CEC NEGOM Program Investigation Report No. 2004-02, April 2004)*

JOANNE LYCZKOWSKI-SHULTZ, DAVID S. HANISKO, NOAA PIs
NOAA/ National Marine Fisheries Service
Mississippi Laboratories, Pascagoula Facility
3209 Frederic St., Pascagoula, Mississippi 39567, USA

KENNETH J. SULAK, USGS PROJECT LEAD SCIENTIST
GEORGE D. DENNIS, III, USGS CO-PI
Coastal Ecology and Conservation Research Group
Center for Aquatic Resource Studies
U.S. Geological Survey
7920 NW 71st St., Gainesville, Florida 32653, USA

CHARACTERIZATION OF ICHTHYOPLANKTON WITHIN THE U.S. GEOLOGICAL SURVEY'S NORTHEASTERN GULF OF MEXICO STUDY AREA

Based on Analysis of
Southeast Area Monitoring and Assessment Program
(SEAMAP) Sampling Surveys, 1982-1999

Undertaken in Response to Gulf of Mexico OCS
Natural Resource Information Management Needs
Of the Minerals Management Service

JOANNE LYCZKOWSKI-SHULTZ, DAVID S. HANISKO, NOAA PIs
NOAA/ National Marine Fisheries Service
Mississippi Laboratories, Pascagoula Facility
3209 Frederic St., Pascagoula, Mississippi 39567, USA
228-762-4591 x277; email joanne.lyczkowski-shultz@noaa.gov

KENNETH J. SULAK, USGS PROJECT LEAD SCIENTIST
GEORGE D. DENNIS, III, USGS CO-PI[1]
Coastal Ecology and Conservation Research Group
Center for Aquatic Resource Studies
U.S. Geological Survey
7920 NW 71st St., Gainesville, Florida 32653, USA
352-264-3500; email ken_sulak@usgs.gov

This USGS Project Report, USGS SIR-2004-5059, is an unpublished technical report. It is not copyrighted and may be cited and copied freely. It is available on CD-ROM upon request from the USGS Project Lead Scientist, and is also available online as either a .pdf or .html file at: http://cars.er.usgs.gov/coastaleco/

Cover Photo: Stereo-microscopic view of ichthyoplankton sorted from a SEAMAP plankton sample collected in the Gulf of Mexico (credit: Pamela J. Bond).

[1] Current address, U.S. Fish and Wildlife Service, Vero Beach, Florida; email: george_dennis @fws.gov

Project Cooperation

This study was undertaken to meet information needs identified by the Department of the Interior, U.S. Geological Survey (USGS), Outer Continental Shelf Ecosystem Program in concert with the Minerals Management Service (MMS). It was undertaken collaboratively by USGS and NOAA/NMFS.

Disclaimer

This report was prepared under the direction of, and in collaboration with, the Florida Integrated Science Center, Center for Aquatic Resource Studies, of the USGS. This report has been technically reviewed by USGS and MMS, and has been approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the USGS or MMS, nor does mention of trade names or commercial products constitute endorsement or recommendation for future use.

Report Availability

This report is also available as a downloadable Adobe® .pdf format and .html format from the Florida Integrated Science Center Website at http://cars.er.usgs.gov/coastaleco/

Copies of this report in CD format may also be obtained from:

U.S. Department of the Interior
Florida Integrated Science Center
Center for Aquatic Resource Studies
Coastal Ecology and Conservation Research Group

Email: ken_sulak@usgs.gov or jana_miller@usgs.gov
Telephone: 352-378-8181 or 353-264-3500

With respect to datasets and the GIS Project analyzed in preparation of this report, refer to **Metadata** section within.

Suggested Citation

Lyczkowski-Shultz, J., D. S. Hanisko, K. J. Sulak, and G. D. Dennis, III. 2004. Characterization of Ichthyoplankton within the U.S. Geological Survey's Northeastern Gulf of Mexico Study Area - Based on Analysis of Southeast Area Monitoring and Assessment Program (SEAMAP) Sampling Surveys, 1982-1999. NEGOM Ichthyoplankton Synopsis Final Report. U.S. Department of the Interior, U.S. Geological Survey, USGS SIR-2004-5059.

Abstract. --- This synthesis was undertaken to characterize the occurrence and abundance of fish eggs and larvae in the northeastern Gulf of Mexico (NEGOM) and to assess the region's relative importance in the early life history of fishes as compared to the entire U.S. Gulf of Mexico. Data for 66 selected taxa from 1,166 bongo and neuston net samples at 72 localities [comprising the UGSG NEGOM Ichthyoplankton Synopsis (UNIS) Study Area] were analyzed. These data were taken during annual Southeast Area Monitoring and Assessment Program (SEAMAP) gulfwide surveys from 1982-1999, and were summarized by the NMFS to accomplish this objective. Comparison of the UNIS Study Area with the overall SEAMAP survey area revealed that the larvae of 16 taxa occurred more frequently and were relatively more abundant in the UNIS Study Area than the entire SEAMAP survey area while for other taxa occurrence and relative abundance were comparable. These taxa represented fishes from mesopelagic, continental shelf, and reef assemblages reflecting the wide diversity of habitats available in the NEGOM and included the young of two important resource taxa, *Rhomboplites aurorubens* (vermilion snapper) and *Seriola* spp. (amberjacks). Distinct distribution patterns were observed among larvae in the UNIS Study Area that appear to be associated with the presence of the DeSoto Canyon. One notable pattern was the predominance of certain taxa to either the west or east of longitude 86.5-87.0^{o} W. Larvae of several characteristic reef-fish families were most common to the east of this apparent zoogeographic faunal discontinuity. An alternative pattern was seen among taxa whose larvae occurred primarily at locations over depth contours outlining the canyon. Additionally, the UNIS Study Area contributed more fish eggs, total larvae, and zooplankton to survey totals than would be expected from the number of samples taken in the study area. This pattern was more evident during spring than fall surveys. It may relate to the close proximity of UNIS Study Area stations to the Mississippi River and the penetration of DeSoto Canyon, with its nutrient-rich deep slope water, into the inner shelf. The consistent presence of fish eggs throughout the NEGOM at mean abundances exceeding 100 eggs per 10 m^2 sea surface indicates that this region of the Gulf of Mexico is an important spawning area. The present synopsis has revealed that the NEGOM, as represented by the UNIS Study Area, should be considered an important, if not critical, habitat for the young stages of a diverse assemblage of fish taxa. The greatest biological deficiency in this synopsis is our current inability to identify the larvae of all species to a consistent taxonomic level.

Over the period of 1997-2002, the U.S. Geological Survey (USGS) undertook a program of investigations to develop knowledge of outer continental shelf (OCS) fish community structure. This program of investigations was conducted by the Coastal Ecology and Conservation (CEC) Research Group, Center for Aquatic Resource Studies, Florida Integrated Science Center, Gainesville, Florida under the auspices of the USGS Outer Continental Shelf Ecosystem Studies Program. This research program responded to the living resource information needs of the Minerals Management Service (MMS) in relation to its ecological stewardship role on the OCS. Investigations conducted by USGS from 1997-1999 emphasized knowledge of sensitive hard-bottom and deep reef ecosystems in areas of hydrocarbon exploration and development. Beginning in 2000, the USGS CEC Research Group initiated a more comprehensive and holistic approach to studies on the OCS both in response to MMS information needs, and to address fundamental deficiencies in our knowledge of OCS ecosystems. USGS research from 2000-2002 was originally planned as a biological complement to a large-scale program of physical oceanographic investigations to be sponsored by MMS, but the physical oceanography component has been deferred. Nonetheless, USGS proceeded with the biological component, placing increased emphasis on integrated oceanographic and comparative biological studies of total ecosystem structure and function. Additional research partners with abiding specialized expertise in this regard were solicited to address specific topics requiring a broad oceanographic perspective, or a pre-existing extended time-series of sampling data.

The present report is the result of NOAA National Marine Fisheries Service (NMFS) collaboration with the USGS in holistic research on fish communities on the OCS in the Northeastern Gulf of Mexico (NEGOM). The Mississippi Laboratories of the NMFS joined the USGS program of investigations contributing special expertise in terms of its long-standing program of research on Gulf of Mexico (GOM) ichthyoplankon under the Southeast Area Monitoring and Assessment Program (SEAMAP) (Rester et al. 2000). Support to the NMFS from the USGS OCS Studies Program enabled an accelerated synopsis of ichthyoplankton occurrence, abundance and geographic distribution in the NEGOM. This knowledge is important to understanding zoogeographic versus habitat factors determining demersal fish community structure differentiation on hard-bottom and deep-reef biotopes. It may also prove valuable in assessing future anthropogenic impacts on larval fish distribution and settlement patterns in areas of hydrocarbon exploration and development.

The present report is the first in an ongoing series of USGS NEGOM investigation reports from research undertaken between 2000-2002. Each deals with a specific component of the overall NEGOM program of integrated studies. The present report also represents one in a continuing series of USGS research reports, Open Files, or publications (Weaver et al. 1999, 2002, Sulak et al. 2000, Gardner et al. 2000, 2001a, 2001b, 2002a, 2002b, 2003, Weaver and Sulak 2000, Thurman et al. 2003) resulting from USGS research undertaken from 1997-2003 on the OCS in the NEGOM.

Methods

SEAMAP Ichthyoplankton Data Base

Ichthyoplankton available for study by NMFS scientists has been collected during fishery-independent gulfwide (the entire northern Gulf of Mexico within the U.S. Exclusive Economic Zone, EEZ) resource surveys in the GOM since 1982 via the SEAMAP (Rester et al. 2000). Data from SEAMAP samples are summarized in this report to describe the occurrence and abundance of fish eggs, total fish larvae, the larvae of selected taxa; and the biomass of net-caught zooplankton in the UNIS Study Area. Samples in the present synopsis were taken during gulfwide plankton sampling surveys conducted in spring (mid April to early June) and late summer/early fall (August to mid October), the principal gulfwide plankton survey timeframes. Sixty-six taxa of fishes, representing the wide diversity of the NEGOM ichthyofauna, were chosen for analyses because their larvae could be identified with confidence.

USGS Study Area and SEAMAP Sampling Sites Analyzed

Prior to initiation of the USGS biological component of the planned MMS Integrated Oceanographic Study - Northeastern Gulf of

Mexico (IOS-NEGOM), the MMS had designated a target study area for the overall program of integrated investigations. This target IOS-NEGOM study area is shown in relation to USGS deep-reef study areas and NMFS hard-bottom fishery resource areas as the large polygon in Figure 1. It is also shown in relation to SEAMAP sampling locations as the shaded polygon in Figure 2. Deep-reef fish community structure investigations undertaken by USGS from 1997-1999 (Weaver et al. 2002) were confined to the "Pinnacles" reef tract within this polygon, but the USGS area of interest was extended eastward beginning in 2000. This eastward geographic extension of investigations was undertaken to gain comparative zoogeographic perspective between deep-reef communities to the east versus west of DeSoto Canyon (Figure 1). Intruding landward deeply into the continental shelf, the canyon may represent a major oceanographic discontinuity and zoogeographic boundary in the GOM in relation to prevailing ocean current patterns and the northward transport of deep, cold, nutrient rich water onto the continental shelf. Thus, patterns of ichthyoplankton dispersal and distribution may differ on either side of the canyon. Accordingly, for the present synopsis of ichthyoplankton in the NEGOM, data from a somewhat larger area than the original MMS IOS-NEGOM polygon were included for analysis (Figure 2).

The overall SEAMAP sampling area covers the entire northern GOM from the 10-m isobath out to the U.S. EEZ, and comprises approximately 300 sampling sites (Figure 3 shows positions of 294 sites). The USGS Ichthyoplankton Synopsis (UNIS) Study Area within the NEGOM includes a subset of 72 sites (Figures 2, 3). The UNIS Study Area is bounded to the east by longitude 84.5^{o} W, and to the west by longitude 88.5^{o} W. It extends from the 10 m isobath seaward roughly to the 1,000 m isobath (Figure 2). The 72 UNIS Study Area sampling sites include 22 sites lying outside the MMS IOS-NEGOM polygon (Figures 2, 3).

SEAMAP Sampling Design

The original plan for SEAMAP plankton surveys was to sample both the continental shelf waters (10-200 m depth range) and open GOM waters (shelf edge at 200 m to the limits of the EEZ (Figure 3). Both of these sectors of the GOM were to be sampled at least once during each season. This ambitious goal could not be achieved due to logistic constraints. Neither all areas, nor all seasons, could be sampled every year gulfwide, with a particular deficiency in winter sampling. Accordingly, SEAMAP ichthyoplankton surveys do not encompass the spawning seasons of all fish species; most of the winter-spawning exploited resource species in the GOM are not included.

SEAMAP ichthyoplankton data were collected primarily during four survey periods: spring (April to early June, annually, 1982 to present), summer (June and July, annually, 1982 to present), late summer/early fall (typically in September, annually, 1986 to present) and fall (October and November, annually, 1982 to present). The spring survey covers only open GOM waters (within the U.S. EEZ), while the summer and fall surveys encompass only continental shelf waters from off southern Texas to Mobile Bay; and the late summer/early fall survey from off southern Texas to off southern Florida. There have been three winter plankton surveys (in 1983, 1984 and 1996) in open GOM waters during the SEAMAP time series. Only surveys conducted in the spring and late summer/early fall timeframes covered the entire extent of the UNIS Study Area and only the data from these surveys (1982-1999) are summarized and presented in the present report. .

Field Methods

The sampling gear and methodology used during SEAMAP surveys (Rester et al. 2000) are similar to those recommended by Kramer et al. (1972), Smith and Richardson (1977) and Posgay and Marak (1980). The bongo net array (pair of mated 61-cm diameter net frames) fitted with 0.335 mm mesh netting is fished in an oblique tow path to a maximum depth of 200 m, or to 2-5 m off the bottom at depths less than 200 m. A mechanical flowmeter is mounted off-center in the mouth of each bongo net to record the volume of water filtered. The frame neuston net is either a single or double 2.0 m by 1.0 m pipe frame fitted with 0.950 mm mesh netting. It is towed at the surface with the frame half-submerged for ten minutes per tow.

SEAMAP stations were located at 30-nautical mile or 0.5^{o} (~56 km) intervals in a fixed, systematic, orthogonal latitude-longitude grid of transects across the GOM. However, only every other longitudinal transect of stations was sampled during spring surveys. Occasionally, samples were taken at non-standard locations or sampling position was altered away from the set station position to avoid navigational hazards. Data from these stations were also included in this report. Samples were taken upon arrival on station regardless of time of day. At each station either a bongo or neuston tow, or both, was accomplished. During the spring survey bongo tows were conducted only at every other station.

Water parameter data consistently gathered throughout SEAMAP surveys included salinity, temperature, and dissolved oxygen (see Rester et al. 2000 for complete description). Although vertical profiles of these parameters were taken, only the values at surface, mid and bottom depths (i.e., 200 m or less) were entered into the database. Optical transmission and fluorescence have been measured beginning about 1993 when sensors for these parameters were added to the CTD. Due to time and funding constraints, physical water mass data collected during SEAMAP surveys were not summarized in this report. However, these data are available upon request from the SEAMAP Data Manager at the NMFS Mississippi Laboratories.

SEAMAP/UNIS Study Area Sample Data Set

The present synoptic characterization of ichthyoplankton in the UNIS Study Area is based on a subset of data from 36 SEAMAP plankton cruises conducted from 1982-1999 (Table 1). Cruises sampled two comparative areas and seasons: 1) the open GOM spring survey (April to early June), and 2) the late summer to early fall continental shelf survey (late August to mid-October), referred hereafter as the fall survey. Data from NOAA R/V *Oregon II* cruise 146, a continental shelf survey in August 1984, were included in the fall survey category.

Seventy-two unique SEAMAP localities or sites (fixed geographic locations) were selected to comprise the UNIS Study Area. SEAMAP sampling stations were undertaken at each location, as identified by SEAMAP site designation number (Figure 2, Table 2).

Of the 72 SEAMAP localities, 12 were sampled only during spring surveys, 43 only during fall surveys, and 17 during both survey types. There was 35-40 percent overlap in spatial coverage during spring and fall surveys (Figure 4, Table 2). Most spring survey sites were located seaward of the 50-m isobath, whereas more than half of fall survey sites were located shoreward of the 50-m isobath.

Ichthyoplankton Processing

Initial processing of SEAMAP plankton samples was accomplished at the Sea Fisheries

Institute, Plankton Sorting and Identification Center, in Szczecin, Poland, under a Joint Studies Agreement with NMFS. Wet plankton volumes of bongo net samples are measured by displacement to estimate net-caught zooplankton biomass (Smith and Richardson 1977). Fish eggs and larvae were removed from bongo net samples, and fish larvae only from neuston net samples. Fish eggs were not identified further, but larvae were identified to the lowest possible taxon (to family in most cases). Body length (either notochord or standard length) was measured. All length data reported herein are body length. For many taxa (especially in the early years of the SEAMAP sampling time series), only size range (i.e., size of the largest and smallest specimens) was recorded. Length data are summarized in this report for 16 taxa and are based only on samples where all captured specimens were measured. Vials of eggs and identified larvae, plankton displacement volume values, total egg counts, and counts and length measurements of identified larvae were sent to the SEAMAP Archive at the Florida Marine Research Institute (FMRI), St. Petersburg, Florida. All data have been entered into the SEAMAP database. Voucher specimens are curated at FMRI, and are available on loan for scientific study and reference.

Catches of fish eggs and larvae in bongo net samples were standardized to account for sampling effort and expressed as number under 10 m^2 sea surface by dividing the number of eggs or larvae by volume filtered and then multiplying the resultant by the product of 10 and maximum depth of tow. This procedure results in a less biased estimate of abundance than number per unit of volume filtered alone and permits direct comparison of abundance estimates across samples taken over a wide range of water column depths (Smith and Richardson 1977). Standardized catches of larvae taken in neuston samples are expressed as number per 10-min tow. Plankton displacement volumes are expressed as ml per 10 m^2 sea surface. Mean values at UNIS localities for bongo and neuston nets by survey type (spring plankton and fall plankton) were based on all samples collected at each locality during surveys from 1982-1999. Comparisons of mean total abundance of fish larvae are based on larvae of all taxa taken in samples and not just those taxa selected for detailed analysis in this report.

Results from the UNIS Study Area were compared to data from all survey samples combined by gear and survey time frame during both SEAMAP spring and fall plankton surveys, 1982-1999 (Figure 3). The number of samples in the UNIS Study Area was expressed as a percentage of the total number of survey samples. The summed abundance of fish eggs and total fish larvae, and summed plankton displacement volume in the UNIS Study Area were expressed as percentages of the corresponding totals for all survey samples combined. The frequency of occurrence and total abundance of the 66 selected taxa in UNIS Study Area samples, and in all SEAMAP survey samples combined, were compared by expressing each as a percentage of the total number of samples and summed total abundance of all fish larvae captured in UNIS Study Area and gulfwide SEAMAP samples, respectively.

SEAMAP/UNIS STUDY AREA Taxonomic Data Subset

The majority of specimens collected in SEAMAP plankton samples and maintained at the Archive have been identified only to the family level. This is not unexpected since the larvae of only 27 percent of the approximately 1,800 species of marine fishes occurring in the central Western Atlantic region (including the GOM) have been described (Kendall and

Matarese 1994). Identification of larvae to the family level, however, is possible for two-thirds of the families of marine fishes (Ahlstrom and Moser 1981, Richards 1990).

We summarized data for only a limited number of taxa due to the limitations of larval fish identifications in the taxonomically rich Gulf of Mexico. Moreover, the large number of specimens available from SEAMAP surveys (>100,000) made it impractical to re-examine and re-identify specimens from all taxa using newly available descriptive information. The larvae of 66 taxa, representing 34 families of fishes, were chosen for analyses because their larvae are distinctive and can be identified with confidence to family, subfamily, genus, or species (Table 3). Also, in the case of the tunas (from spring survey samples), mackerels, and snappers, most specimens have been re-identified in relation to management information need priorities.

Taxa selected for treatment herein were chosen using these criteria: 1) larvae could be reliably identified throughout the time series, 2) larvae had been re-examined to validate identifications, 3) larvae were identified as belonging to selected families considered to be highly associated with reef environments (as per Sale 1991). Identification of larvae under criterion 3 [Holocentridae, Serranidae (in part), Priacanthidae, Apogonidae, Haemulidae, Chaetodontidae, Ponacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae] is problematic. However, as adults, species in these taxa often comprise key members of OCS hard-bottom and deep-reef communities in the NEGOM.

The subset of taxa chosen for analyses of ichthyoplankton in the UNIS Study Area represents the wide diversity of the NEGOM ichthyofauna and includes both key ecological and resource species. These taxa are representative of the tropical and warm temperate epipelagic, mesopelagic, coastal shelf and demersal (including reef), and pelagic species found in the northern Gulf of Mexico (Richards et al. 1993).

Results

Fish eggs were present throughout the UNIS Study Area. Mean abundance of fish eggs from spring surveys was 467 (n = 100), and from fall surveys 407 (n = 176) eggs per 10 m^2. Mean egg abundances at localities where at least one sample was obtained generally ranged between 120 to 600 in the spring and 200 to 400 in the fall (Figure 5). There were no apparent within region differences in egg abundance. The number of samples sorted for fish eggs in the UNIS Study Area represented 11 percent of the total number of samples with egg counts for all spring survey samples, yet the summed abundance of fish eggs in the UNIS Study Area accounted for 21 percent of total survey egg abundance (Table 4). Egg abundance in the UNIS Study Area during fall surveys corresponded to the proportion of total survey samples taken in the area, approximately 20 percent.

Fish larvae were taken in each of the 499 bongo net collections and in all but 2 of the 667 neuston net collections in the UNIS Study Area. Overall mean total abundance of fish larvae (all taxa combined) from the two survey timeframes was similar; 1,354 and 1,158 larvae under 10 m^2, and 148 and 147 larvae per 10-min tow, in spring and fall surveys, respectively. Mean total abundances of fish larvae in bongo net samples at localities where at least one sample was obtained ranged from 529 to 2,745, and 302 to 2,239 larvae per 10 m^2 during spring and fall surveys, respectively. Mean total abundances of larvae in neuston collections at localities where at least one sample was obtained ranged from 43 to 571, and 27 to 1,140 larvae per 10-min tow in spring and fall surveys, respectively. Mean total abundances were relatively uniform throughout the area especially where estimates were based on more than five samples (Figure 6). The only indication of within region differences in larval fish abundance appeared in the fall when neuston collected larvae tended to be more abundant at localities inshore of the 50 m isobath than offshore of it.

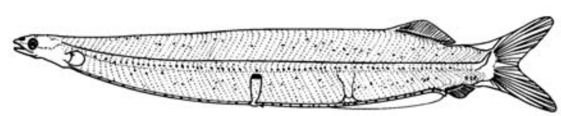
The relative contribution of UNIS Study Area samples to the total abundance of fish larvae differed somewhat between the two survey time frames (Table 4). In the spring, summed abundance of total fish larvae captured by bongo nets in the UNIS Study Area was 5 percent higher than gulfwide, but in the fall was 2 percent lower than would be expected based on the number of survey samples taken in the UNIS Study Area. Observed differences in UNIS Study Area and gulfwide survey total abundance was even more pronounced for fish larvae collected in neuston samples. During spring surveys the UNIS Study Area contributed only 12 percent of the total number of survey samples but larvae captured in neuston samples there accounted for 21 percent of total survey abundance. During fall surveys the UNIS Study Area contributed 22 percent of the total number of survey samples but larvae captured in neuston samples there accounted for only 16 percent of total survey abundance.

Volume of water filtered for bongo net samples ranged from 22-555 m^3, but was typically 30-40 m^3 at the shallowest stations and 300-400 m^3 at the deepest stations in the UNIS Study Area. Mean plankton displacement volume for all localities in the UNIS Study Area combined was higher in spring: 149 (n= 153) ml per 10 m^2, than in fall: 111 (n=332) ml per 10 m^2. There were no clear within-area differences in mean net-caught zooplankton biomass in the study area (Figure 5). Mean displacement volumes exceeded 150 ml per 10 m^2 in the spring, and 100 ml per 10 m^2 in the fall, at localities throughout the study area. During both spring and fall surveys the contribution of UNIS Study Area samples to the total summed survey plankton displacement volume was proportionately higher than would be expected based on the allocation of samples in the area (Table 4). During spring surveys the UNIS Study Area contributed only 11 percent of the total number of survey samples, but summed zooplankton displacement volume accounted for 13 percent of survey total. During fall surveys the UNIS Study Area contributed 21 percent of the total number of survey samples, but summed zooplankton displacement volume accounted for 28 percent of the survey total.

Synopses of Selected Major Ichthyoplankton Taxa

Synopses of occurrence, abundance and distribution of the pelagic early life stages of 66 taxa of fishes collected during SEAMAP surveys in the UNIS Study Area are presented below. Occurrence and total abundance of each taxon in the UNIS Study Area are compared to these same parameters gulfwide, thereby providing a measure of the relative contribution of the UNIS Study Area to production of early life stages.

Elopidae



(7 occurrences; 16 larvae)
Figure 7

Elopid species have a leptocephalus larval form with a forked tail, which distinguishes them from the leptocephali of spiny and true eels. It is likely that all these elopid larvae were ladyfish, *Elops saurus*, given the general rarity of tarpon, *Megalops atlantica*, in collections and the distinctive forward placement of the dorsal fin relative to the anal fin in larval bonefish, *Albula vulpes*. Elopid leptocephali occurred only seven times, all during fall surveys, with occurrences almost equally divided between bongo (three) and neuston (four) net samples. The localities of all three occurrences in bongo and three of four occurrences in neuston samples were along or west of longitude 87° W (Figure 7). Eleven of the 16 specimens captured were taken in neuston collections. Elopid larvae were represented in the UNIS Study Area in about the same relative proportion as in gulfwide surveys overall (Table 5).

Muraenidae

(83 occurrences; 188 larvae)
Figure 8

Moray eels are a characteristic component of hard/live bottom communities throughout the GOM. Their leptocephalus larvae can be distinguished from the young of other eel families by the complete absence or greatly reduced state of their pectoral fins. Moray eel leptocephali occurred more frequently in fall surveys than in spring, 71 versus 12 occurrences; and were captured more often in neuston than in bongo samples, 60 versus 23 (Table 3). These larvae were found, for the most part, at the most offshore localities during spring surveys, but were dispersed throughout the UNIS Study Area during fall surveys, from the closest inshore to the farthest offshore localities (Figure 8). Highest mean abundances were observed during fall surveys. Muraenid eel larvae were about as common in the UNIS Study Area collections as they were throughout the GOM except in fall surveys when they occurred nearly 1.5 times more frequently in the UNIS Study Area neuston collections than in all survey neuston collections combined (Table 5).

Clupeidae

(371 occurrences; 11,541 larvae)
Figure 9

This taxon comprises larvae of four taxa identified to species, one to genus and specimens originally identified to family. Only anchovy larvae outnumbered herring larvae in UNIS Study Area samples (Table 3). Herring larvae were taken more often and in greater numbers in neuston than in bongo samples, and during fall than in spring surveys (Table 3). Herring larvae were widely distributed throughout the UNIS Study Area with greatest mean abundances observed at localities inshore of the 50 m contour (Figure 9). Comparison with gulfwide collections indicated a distinct difference between spring and fall surveys in the frequency of herring larvae occurrence (Table 5). Larvae were collected twice as frequently in the UNIS Study Area survey area as in the entire survey area during spring surveys when most collections were made in offshore waters. The pattern was reversed during fall surveys when herring larvae occurred more frequently in gulfwide collections than in UNIS Study Area collections, although the difference was not as great as was the case for spring surveys.

***Brevoortia* spp.**

(1 occurrence; 1 larva)

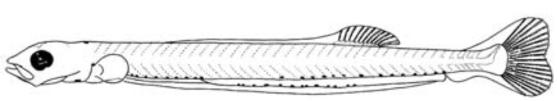
Menhaden spawn in offshore waters of the GOM in early winter, therefore, it is not surprising that only a single menhaden larva was captured in the UNIS Study Area and that capture was in a spring survey neuston collection (Table 3). Menhaden larvae were taken at other locations in surveys during both fall and spring but at frequencies of less than 1 percent, i.e., comparable to the frequency of occurrence in the UNIS Study Area (Table 5).

Etrumeus teres

(56 occurrences; 1,306 larvae)
Figure 10

Larvae of the round herring, a winter spawning clupeid, were found in the UNIS Study Area almost exclusively during spring surveys (Table 3). Incidence of capture in bongo and neuston samples was similar, but larvae were nearly three times more numerous in neuston than in bongo collections. Most occurrences and the highest mean abundances were observed at localities along or east of longitude 87° W (Figure 10). Round herring were taken more than twice as frequently in UNIS Study Area samples than in gulfwide SEAMAP samples during spring surveys but at comparable rates during fall surveys (Table 5). They were somewhat more abundant in the UNIS Study Area than gulfwide.

Harengula jaguana



(137 occurrences; 3,909 larvae)
Figure 11

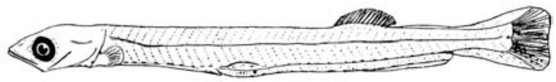
Scaled sardine larvae ranked second in occurrence and abundance among the clupeid larvae identified to species (Table 3). Although fall survey collections accounted for two-thirds of their occurrences, nearly twice as many scaled sardine larvae were taken during spring surveys. Larvae were captured 3.5 times more often and were over an order of magnitude more numerous in neuston than bongo net samples. In the spring, highest mean abundances of scaled sardine larvae were observed west of longitude 87° W while during fall surveys larvae were distributed across the UNIS Study Area with greatest mean abundances inshore of the 50 m contour (Figure 11). Scaled sardine larvae were taken more than twice as frequently in neuston collections in the UNIS Study Area than gulfwide during spring surveys but at comparable frequencies of occurrence in fall survey neuston collections (Table 5).

Opisthonema oglinum

(89 occurrences; 1,163 larvae)
Figure 12

Atlantic thread herring larvae were more numerous and occurred more frequently in fall than in spring surveys; and unlike the other abundant clupeid larvae they were more frequently taken and more numerous in bongo than in neuston net samples (Table 3). Larvae were not found east of longitude 87° W during spring surveys but occurred throughout the UNIS Study Area during fall surveys when most occurrences and highest mean abundances were observed inshore of the 50 m contour and east of longitude 87° W (Figure 12). Both occurrence and abundance of Atlantic thread herring larvae were relatively higher in gulfwide surveys overall than in the UNIS Study Area (Table 5).

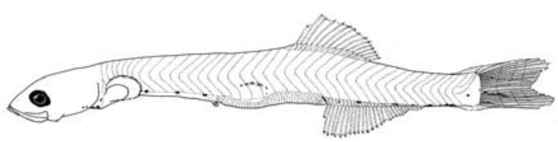
Sardinella aurita



(148 occurrences; 4,360 larvae)
Figure 13

Larvae of the Spanish sardine were the most frequently taken and most abundant larval clupeid in the UNIS Study Area (Table 3). Larvae were taken almost exclusively during fall surveys and were comparably represented in bongo and neuston samples. Larvae occurred most frequently and in highest abundance at localities east of longitude 87° W and generally over depths exceeding 100 m (Figure 13). Spanish sardine larvae occurred at about the same frequency (19-20 %) and in about the same relative proportion in the UNIS Study Area and gulfwide (Table 5).

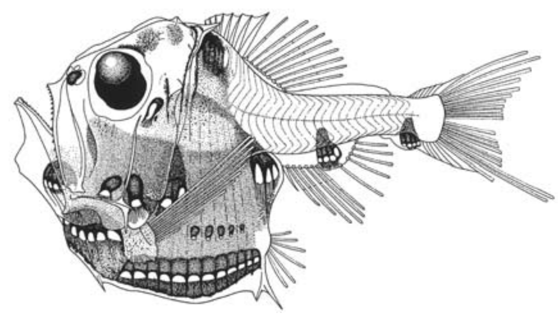
Engraulidae



(573 occurrences; 40,732 larvae)
Figure 14

Anchovy larvae were the most frequently caught and most numerous of all fish larvae in UNIS Study Area collections. At least six species of engraulids are known to occur over the continental shelf in the NEGOM, but their larvae cannot be easily distinguished from one another until later in the juvenile stage. All but 97 of the 573 occurrences were from fall surveys, with specimens taken in these collections outnumbering those in spring collections by an order of magnitude (Table 3). Anchovy larvae were taken as frequently in bongo as in neuston samples but larvae were somewhat more numerous in neuston samples. As would be expected anchovy larvae occurred throughout the survey area but highest mean abundances were consistently observed in the westernmost region from nearshore to the most offshore localities and elsewhere in the UNIS Study Area inshore of the 50 m contour (Figure 14). During spring surveys the frequency of occurrence of anchovy larvae was higher in the UNIS Study Area than in the gulfwide survey area (Table 5). During fall surveys frequency of occurrence of anchovy larvae in the UNIS Study Area was similar to occurrence gulfwide, but the relative proportion of anchovy larvae in the UNIS Study Area exceeded their proportion in all gulfwide survey samples combined.

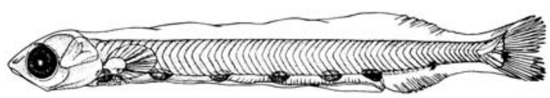
Sternoptychidae



(210 occurrences; 3,533 larvae)
Figure 15

Larvae of the bioluminescent mesopelagic and bathypelagic hatchet fishes were fairly numerous in UNIS Study Area collections during both spring and fall surveys (Table 3). Hatchet fish larvae were taken almost exclusively in bongo samples and at localities beyond 50 m and along the contours outlining the DeSoto Canyon (Figure 15). Mean abundances at offshore localities consistently ranged from 10 to 100 larvae per 10 m^2. Hatchet fish larvae occurred more frequently in the UNIS Study Area than in the entire gulfwide survey area and were somewhat more abundant there as well (Table 5). This difference was more pronounced during fall surveys when hatchet fish larvae were more numerous.

Synodontidae



(501 occurrences; 7,229 larvae)
Figure 16

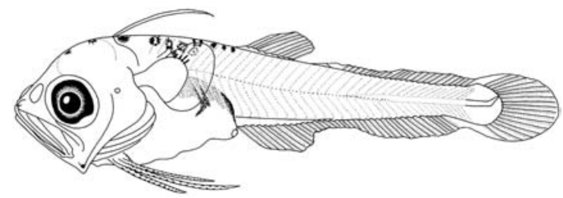
The lizardfishes are an important group of benthic predatory fishes common on soft bottom substrates of the continental shelf in the GOM and are considered an important member of halo communities extending away from reefs. Their larvae were among the more frequently taken and numerous larvae in SEAMAP plankton collections. Most lizardfish larvae were taken in bongo net collections during fall surveys (Table 3). These ubiquitous larvae were taken in bongo net samples at all but three UNIS Study Area localities during fall surveys (Figure 16). The highest mean abundances were found at localities between the 50 m and 200 m contours. Although relative abundance was comparable in both areas, lizardfish larvae were more frequently caught in the UNIS Study Area than in the gulfwide survey area (Table 5).

Paralepididae

(215 occurrences; 1,053 larvae)
Figure 17

The barracudinas occur in epipelagic, mesopelagic, and bathypelagic zones of the GOM. Their larvae were not uncommon in the UNIS Study Area, occurring most often and in greatest numbers in bongo collections during spring surveys (Table 3). The distribution of barracudina larvae, like hatchet fish larvae, followed the isobaths outlining the DeSoto Canyon across the full east to west extent of the UNIS Study Area (Figure 17). Mean abundances from bongo samples at most localities beyond the 100 m contour typically exceeded 50 larvae under 10 m^2. Frequency of occurrence and relative abundance in the UNIS Study Area and the gulfwide survey areas were comparable (Table 5).

Bregmacerotidae



(441 occurrences; 9,918 larvae)
Figure 18

Codlets are generally known as epipelagic planktivores, but have been documented feeding epibenthically and intensely on reef-top habitat at night on NEGOM "Pinnacles Tract" reefs (K. Sulak, USGS, unpublished videotape data). Codlet larvae were common throughout the UNIS Study Area during both spring and fall, but most larvae were taken in bongo samples during fall surveys (Table 3). Mean abundances at localities exceeding 100 larvae under 10 m^2 were typical, especially in the southwestern corner of the UNIS Study Area, the head of the DeSoto Canyon and its eastern slopes (Figure 18). High frequencies of occurrence, over 80 percent in the spring and over 55 percent in the fall, were observed in both the UNIS Study Area and gulfwide with codlet larvae present at comparable relative abundances (Table 5).

Carapidae

(22 occurrences; 62 larvae)
Figure 19

Planktonic larvae of the pearlfishes are distinctive in having a vexillum, or long, thread-like dorsal process, anterior to the dorsal fin. Most species live as inquilines in the body cavity of certain benthic invertebrates, but have free-living planktonic larvae. Three species occur in the western central Atlantic; *Carapus bermudensis, Echiodon dawsonii*, and *Snyderidia canina*. The last species is thought to be free-living, but has been observed sheltering beneath the recumbent spines of the large, white, deep-water "pancake" urchin, *Araeosoma* (K. Sulak, USGS, unpublished submersible observations). Pearlfish larvae not identified as *C. bermudensis* (see below) were captured almost exclusively in bongo collections during fall surveys (Table 3). Highest mean abundances were found at localities in the southwestern and southeastern corners of the UNIS Study Area (Figure 19). Occurrence of pearlfish larvae was somewhat higher in the UNIS Study Area than gulfwide but relative abundances were comparable (Table 5).

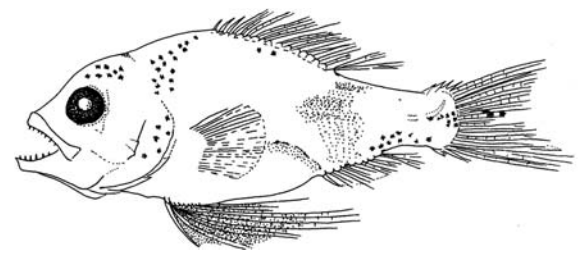
Carapus bermudensis

(68 occurrences; 210 larvae)

Figure 20

Larvae of the pearlfish, *C. bermudensis,* were taken more frequently and in greater numbers during fall than spring surveys in bongo samples. Larvae of this species were never taken in neuston collections (Table 3). Most captures of larvae were made at localities east of longitude 87° W and generally over depths exceeding 50 m (Figure 19). This was unlike the pattern among larvae identified only to the family level, which were captured somewhat more often in the southwestern corner of the UNIS Study Area (Figure 20). Larvae of *C. bermudensis* were taken more frequently in the UNIS Study Area than in the gulfwide survey area, especially during fall surveys when respective percent occurrences were 17 and 10 (Table 5).

Melamphaidae

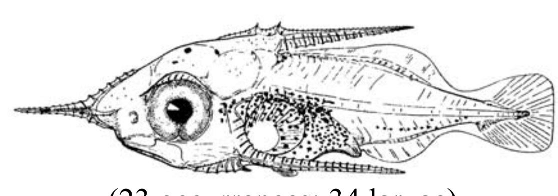


(58 occurrences; 90 larvae)

Figure 21

The melamphaids (bigscales) are mesopelagic and bathypelagic fishes whose larvae were taken in the UNIS Study Area almost exclusively in bongo samples, and were more common during spring than fall surveys (Table 3). Most occurrences and highest mean abundances were observed at localities where station depths exceeded 100 m (Figure 21). Bigscales larvae occurred relatively more frequently gulfwide than in the UNIS Study Area during spring surveys, but percent occurrence was comparable for the two survey areas during fall surveys (Table 5).

Holocentridae



(23 occurrences; 34 larvae)

Figure 22

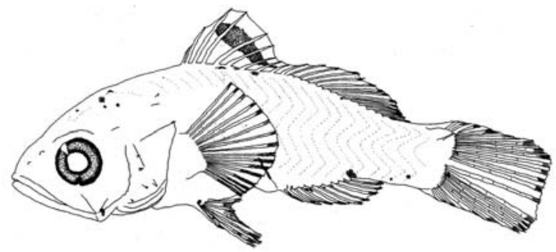
Holocentrids (squirrelfishes) are nocturnal reef fishes, often living cryptically within reef crevices and caves. Their larvae and neustonic prejuvenile ('rhynchichthys') stages are very distinctive. However, identification beyond the family level is problematic (Lyczkowski-Shultz et al. 2000). Larvae were taken primarily in neuston collections and were as frequently taken and as numerous in both spring and fall surveys (Table 3). Mean size in neuston collections was 10.4 mm (n = 18, range = 3.0-26.8 mm); mean size in bongo samples was 2.0 mm (n = 4, range = 1.8-2.2 mm). Occurrences within the UNIS Study Area were restricted to localities where depths exceeded 200 m (Figure 22). Most squirrelfish larvae, however, were taken at SEAMAP stations outside the IOS-NEGOM polygon, either at more offshore localities over depths exceeding 500 m, or to the southeast at comparable and shallower depths (Figure 22). Squirrelfish larvae were taken more frequently over the entire gulfwide survey area than in the UNIS Study Area during both surveys (Table 5).

Serranidae

(320 occurrences; 1,415 larvae)
Figures 23-27

Serranid larvae were nearly ubiquitous and homogeneously distributed throughout the UNIS Study Area. They were taken more frequently in bongo than neuston samples, and more frequently during fall than spring surveys. They were sampled relatively more often in the UNIS Study Area than gulfwide (Tables 3 and 5). Larvae in this category were not identified beyond the family level because they had not developed certain key characteristics that would permit identification to one of the five serranid subfamilies. Larvae within these subfamilies are distinctive and can be identified once diagnostic characters such as head, dorsal and pelvic spines are developed (Richards 1999). It is likely that most of the larvae identified to the family level only belonged to the subfamily Serraninae since larvae of this taxon were the most numerous among those that could be identified.

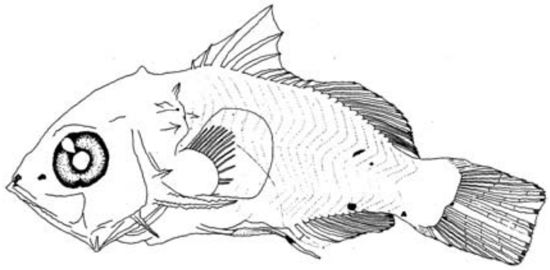
Serraninae



(236 occurrences; 1,672 larvae)
Figure 23

Sea bass larvae of the subfamily Serraninae occurred more frequently and in greater numbers than any of the other four subfamilies of sea basses. This taxon comprises species of genera such as the soft bottom dwelling *Centropristis* and *Diplectrum*; and the reef dwelling *Hypoplectrus* and *Serranus*. Over 67 percent of the occurrences and specimens of serranine larvae were captured in bongo samples, and over 75 percent of the larvae were collected during fall surveys (Table 3). Mean size in neuston collections was 4.17 mm (n = 297, range = 2.1-11.5 mm); mean size in bongo samples was 3.60 mm (n = 508, range = 1.5-12.1 mm). Larvae were found at both the shallowest and deepest localities during spring surveys, whereas during fall surveys, serranine larvae occurred most often at localities inshore of the 100 m isobath, with highest mean abundances in the eastern region of the UNIS Study Area (Figure 23). Relative occurrence and abundance were comparable in both the UNIS Study Area and gulfwide (Table 5).

Anthiinae



(72 occurrences; 182 larvae)
Figure 24

Larvae of the subfamily Anthiinae (streamer basses) were third in occurrence and abundance among serranid larvae taken in the UNIS Study Area. In the GOM this subfamily comprises species in the genera *Anthias*, *Hemanthias*, and *Pronotogrammus*. All species are abundant planktivores and ecologically important components of deep reef ecosystems in the NEGOM (Weaver et al. 2002). Most larvae were taken in bongo samples and during spring surveys, with greatest mean abundances from localities between 200-400 m (Table 3; Figure 24). Mean size in neuston collections was 3.9 mm (n = 55, range = 2.5-5.5 mm); mean size in bongo samples was 3.1 mm (n = 108, range = 1.2-10.0 mm). Distribution of anthiine larvae during fall surveys closely followed the isobaths outlining the DeSoto Canyon between longitudes 87.5º and 85.5º W with larvae being collected at localities between 50-200 m (Figure 24). Occurrence and relative abundance of anthiine larvae were comparable between the UNIS Study Area and gulfwide. However, larvae occurred nearly twice as frequently in the UNIS Study Area survey area than gulfwide in fall survey bongo samples (Table 5). This difference is ecologically meaningful, since anthiine fishes are characteristic reef-dwellers.

Epinephelinae

(3 occurrences; 5 larvae)
Figure 25

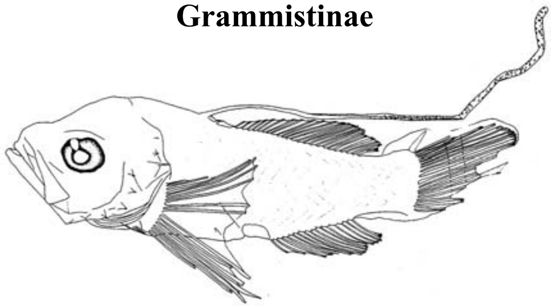
This subfamily includes the groupers, many of which are important resource species, and most of which are reef associates. Only five grouper larvae were taken within the UNIS Study Area, all in bongo samples, and all during spring surveys (Table 3). Mean length was 3.4 mm (n = 5, range = 1.6-6.1 mm). Larvae were taken at three localities within the UNIS Study Area at or east of longitude 87º W, over the 200-1,000 m isobaths (Figure 25). Grouper larvae were captured an additional 32 times gulfwide: 27 occurrences in spring surveys and five occurrences in fall surveys; 30 occurrences in bongo samples, and two occurrences in neuston samples (Table 5).

Liopropomatinae

(1 occurrence; 1 larva)
Figure 26

The Liopropomatinae (basslets) inhabit reef ledges and drop-offs. In SEAMAP samples within the UNIS Study Area, their larvae were encountered even more rarely than grouper larvae. A single 9.0 mm specimen was captured in a spring survey neuston sample at a locality on the 87º W meridian between 500-1,000 m (Table 3, Figure 26). Basslet larvae were captured an additional 19 times gulfwide: 11 occurrences in spring, eight occurrences in fall; 12 occurrences in bongo samples, seven occurrences in neuston samples (Table 5).

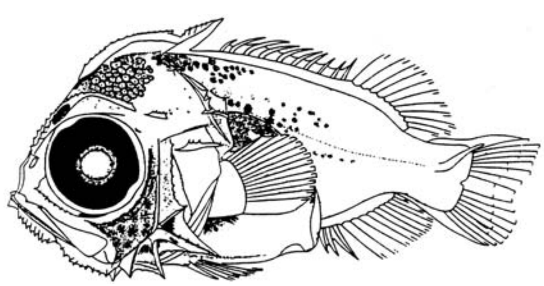
Grammistinae



(117 occurrences; 215 larvae)
Figure 27

Larvae of the soapfish subfamily were the second most commonly encountered serranid larvae in the UNIS Study Area. Larvae were more often captured in bongo than in neuston samples. Over 80 percent were taken during fall surveys (Table 3). Mean size in neuston collections was 5.4 mm (n = 61, range = 2.8-16.0 mm); mean size in bongo samples was 3.9 mm (n = 125, range = 1.3-11.8 mm). Soapfish larvae were distributed throughout the UNIS Study Area, but were more common east of longitude 87.5º W (Figure 27). Frequencies of occurrence and relative abundances in the UNIS Study Area and gulfwide survey areas were comparable (Table 5).

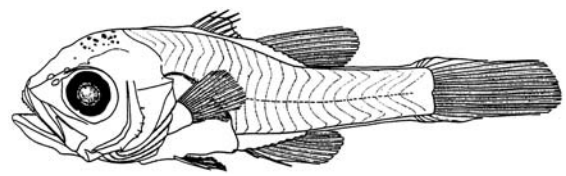
Priacanthidae



(109 occurrences; 239 larvae)
Figure 28

Priacanthids (bigeyes) are shallow to deep water, hard-bottom dwelling fishes, and typical inhabitants of NEGOM deep reefs (Weaver et al. 2002). Their life history includes a pelagic juvenile stage. Larvae were equally represented in bongo and neuston collections in the UNIS Study Area. However, most occurrences and specimens were taken during fall surveys (Table 3). Mean size in neuston collections was 4.7 mm (n = 49, range = 2.4-18.0 mm); mean size in bongo samples was 2.9 mm (n = 71, range = 1.4-6.8 mm). Priacanthid larvae were distributed throughout the UNIS Study Area, but larvae were taken more often at localities east of longitude 87º W (Figure 28). Frequency of occurrence and relative abundance in the UNIS Study Area and gulfwide were comparable (Table 5).

Apogonidae

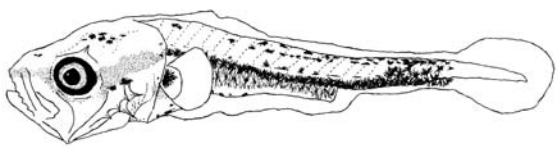


(169 occurrences; 579 larvae)
Figure 29

The cardinalfishes are planktivorous, nocturnal fishes usually associated with reefs. Their larvae hatch with functional mouths and pigmented eyes. Subsequently, the larvae of many species are mouth-brooded prior to dispersal into the plankton (Thresher 1984). Definitive identification of larvae as belonging to the Apogonidae is problematic prior to median fin base formation (Leis and Rennis 1983). Despite this uncertainty, data on SEAMAP larvae identified as apogonids are summarized herein. Potentially misidentified larvae (i.e., belonging to another fish family) are probably an insignificant fraction of the total putative apogonids. Cardinalfish larvae were captured only slightly more often in bongo than in neuston samples, but larvae were more common and numerous in fall than in spring survey samples (Table 3). Mean size in neuston collections was 4.5 mm (n = 60, range = 2.9-15.0 mm); mean size in bongo samples was 3.6 mm (n = 94, range = 1.5-10.5 mm). Apogonid larvae were taken more often and were more numerous at localities east of longitude 87º W during both surveys (Figure 29). Larvae were relatively more common in the UNIS Study Area than in the gulfwide survey area during spring surveys, but were less common in the UNIS Study Area during fall surveys (Table 5).

Rachycentridae

Rachycentron canadum

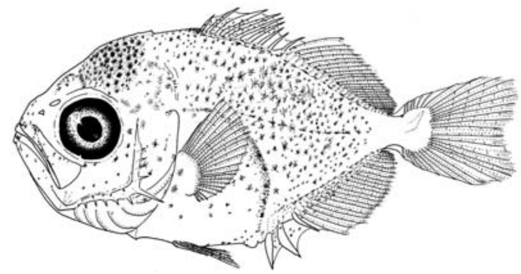


(5 occurrences; 21 larvae)
Figure 30

The cobia is a coastal migratory species, highly prized in the recreational fishery. Cobia larvae are rarely taken in plankton collections. They occurred only five times in UNIS Study Area collections. All were obtained in neuston samples, with most specimens (17) taken during spring surveys (Table 3). Larvae were captured at four different localities, all along or west of longitude 87º W (Figure 30). Water depth at the sites of capture during spring surveys exceeded 500 m, in contrast to water depths of approximately 200 m at capture sites during fall surveys. More cobia larvae were taken in the UNIS Study Area during spring than fall surveys, while the reverse was true gulfwide. Percent occurrence and relative abundance of cobia larvae in UNIS Study Area and gulfwide neuston collections were comparable during spring surveys, but occurrence and abundance was higher gulfwide during fall surveys (Table 5).

Carangidae

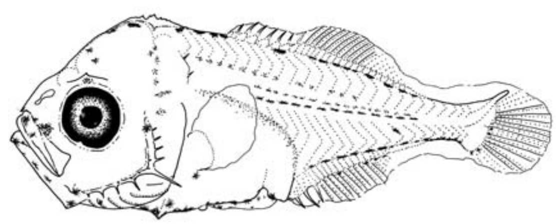
***Caranx* spp.**



(183 occurrences; 1,449 larvae)
Figure 31

Jacks are ecologically important both as predators (all life history stages after hatching) and prey (particularly the young stages). A few species are important in the commercial and recreational fisheries in the GOM. The young of many jacks cannot be reliably identified to species. However, identification to genus is straightforward, even at small sizes. Larvae were taken primarily in neuston samples, but with equal frequency in both spring and fall surveys (Table 3). Jack larvae occurred more consistently and in greater numbers in the western region of the UNIS Study Area, west of longitude 87º W (Figure 31). Larvae occurred somewhat more frequently gulfwide than in the UNIS Study Area, especially during spring surveys (Table 5).

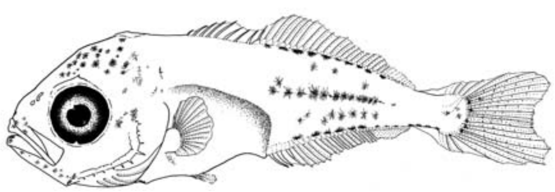
Chloroscombrus chrysurus



(206 occurrences; 14,916 larvae)
Figure 32

Throughout the species range, Atlantic bumper young are most often seen in commensal association with jellyfishes. Larvae and juveniles were second in occurrence, but first in abundance among carangid larvae captured in the UNIS Study Area (Table 3). Although they were taken almost as frequently in bongo as in neuston samples, over 90 percent of specimens were captured in neuston collections. All but one occurrence (eight specimens) came during fall surveys. Larvae were taken throughout the NEGOM, but the highest mean abundances were found well within the 50 m isobath and at the northernmost localities within the UNIS Study Area (Figure 32). Atlantic bumper larvae, like *Caranx* spp., larvae, were taken more consistently and in greater numbers farther offshore in the southwestern region of the UNIS Study Area, as compared to the southeastern region. Percent occurrence gulfwide was nearly twice that in the UNIS Study Area; larvae were over three times more abundant gulfwide than in the UNIS Study Area (Table 5).

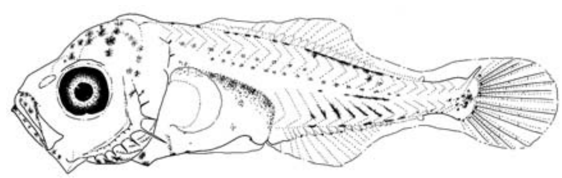
Decapterus spp.



(479 occurrences; 7,101 larvae)
Figure 33

Three species of *Decapterus* may occur in the GOM, but the most common species is *Decapterus punctatus*, the round scad. It is likely that the majority of scad larvae identified to this taxon are *D. punctatus* larvae (the only species of the genus whose larvae have been described). *Decapterus* larvae were the most frequently captured gulfwide and were second in abundance among carangid larvae in the UNIS Study Area (Table 3). Unlike Atlantic bumper larvae, scad larvae were as frequently captured and as numerous in bongo as in neuston samples (Table 3). Most larvae (87 percent of occurrences and 94 percent of the specimens) were taken during fall surveys. Unlike the two previous discussed taxa, *Decapterus* larvae were nearly homogeneously distributed throughout the UNIS Study Area, from east to west, and onshore to offshore (Figure 33). *Decapterus* larvae also differed from *Caranx* and *Chloroscombrus* larvae in that they occurred more frequently and in relatively higher abundance in the UNIS Study Area than gulfwide during fall surveys (Table 5).

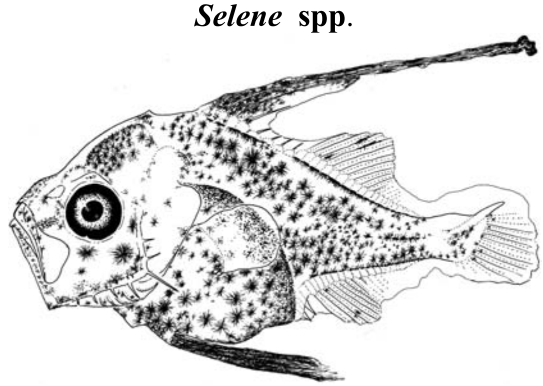
Selar crumenophthalmus



(99 occurrences; 710 larvae)
Figure 34

Young bigeye scad, although relatively numerous, did not occur as frequently as the previously treated carangid taxa. Bigeye scad larvae were captured about as often in bongo as in neuston collections, but most specimens (83%) were taken in neuston samples during fall surveys (Table 3). Larvae were widely distributed from east to west within the UNIS Study Area but were more restricted in onshore/offshore distribution. Most occurrences were at localities between the 50-200 m isobaths (Figure 34). Frequency of occurrence and relative abundance in the UNIS Study Area and the gulfwide were comparable during fall surveys (Table 5).

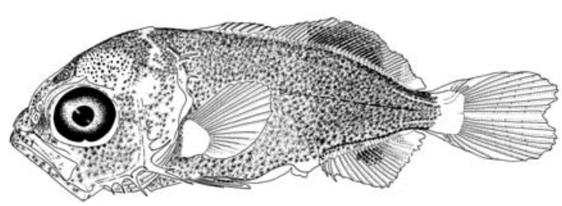
***Selene* spp.**



(34 occurrences; 53 larvae)
Figure 35

The young of three species of moonfish and lookdowns may occur in the GOM. Larvae were taken as often and in about the same numbers in bongo and neuston samples but all captures were made during fall surveys (Table 3). Most occurrences were at localities between 50 and 200 m, but captures over greater depths were made in the southwestern region of the UNIS Study Area (Figure 35). *Selene* larvae were taken more frequently in gulfwide surveys than in UNIS Study Area bongo samples. However, relative abundance from neuston samples was comparable between the two survey areas (Table 5).

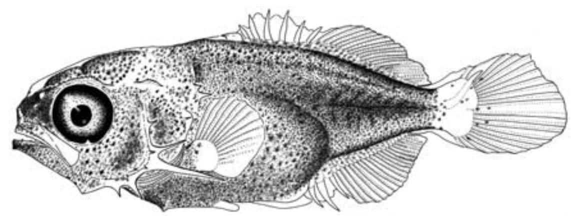
***Seriola* spp.**



(123 occurrences; 461 larvae)
Figure 36

Four species of amberjacks may be represented among the larvae and juveniles in this taxon. Species identification among *Seriola* larvae remains problematic. Young amberjack were taken almost exclusively in neuston collections, and during spring surveys (Table 3). Although amberjack larvae were taken throughout the UNIS Study Area, most captures were made at localities east of longitude 87º W (Figure 36). Frequency of occurrence and relative abundance in the UNIS Study Area and gulfwide were comparable (Table 5).

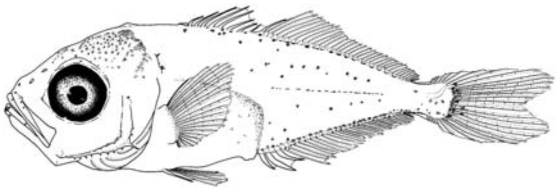
***Trachinotus* spp.**



(46 occurrences; 85 larvae)
Figure 37

Three or four species of pompanos may be represented among the larvae and juveniles in this taxon, all of which were captured in neuston samples and mostly during spring surveys (Table 3). Pompano young occurred not only at the shallowest, nearshore localities but also at some of the furthest offshore localities. This pattern may be indicative of species-specific distribution patterns among the larvae of the different *Trachinotus* species (Figure 37). Pompano larvae were somewhat more frequently taken in spring neuston samples in the UNIS Study Area than gulfwide, but during fall surveys frequency of occurrence was comparable in both survey areas (Table 5).

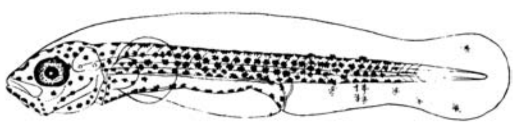
Trachurus lathami



(16 occurrences; 61 larvae)
Figure 38

The young of this late winter spawning species were taken mostly in neuston samples and only during spring surveys (Table 3). Most rough scad larvae were captured at localities near or seaward of the 200 m isobath across the UNIS Study Area (Figure 38). Frequency of occurrence and relative abundance in the UNIS and gulfwide survey areas were comparable during spring surveys (Table 5).

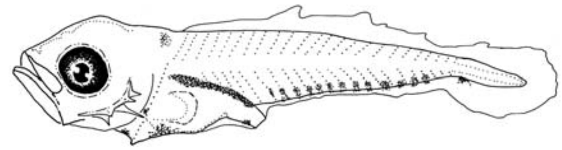
Coryphaenidae



(187 occurrences; 438 larvae)
Figure 39

The young of two species of dolphins are combined in this taxon, *Coryphaena equisetis* and *C. hippurus*. Although taken in bongo samples as well, most *Coryphaena* spp. larvae were collected in neuston samples, with over half the occurrences and over 60 percent of the specimens being taken during spring surveys (Table 3). Young dolphins were distributed throughout the UNIS Study Area during both survey timeframes. Mean abundances were fairly uniform across the UNIS Study Area in the spring, but higher mean abundances were observed in the western region during the fall (Figure 39). Frequency of occurrence and relative abundance in the UNIS and gulfwide survey areas were comparable (Table 5).

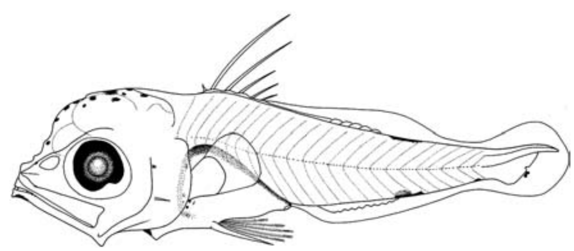
Lutjanidae



(190 occurrences; 728 larvae)
Figure 40

Snapper larvae identified to the family level only were generally <3.0 mm in BL, and/or did not exhibit dorsal spine development sufficient to permit identification to genus or species. Larvae were taken almost exclusively in bongo samples during fall surveys (Table 3). Small, early stage snapper larvae were ubiquitously distributed with typical mean abundances of 10-50 larvae under 10 m^2 throughout the area (Figure 40). Frequency of occurrence and relative abundance in the UNIS Study Area and gulfwide survey area were comparable (Table 5).

Pristipomoides aquilonaris



(74 occurrences; 208 larvae)
Figure 41

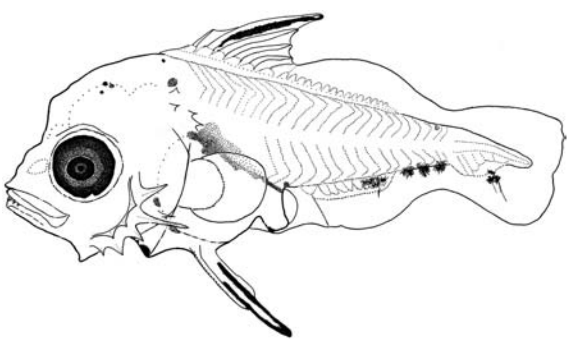
Larvae of this small snapper, the wenchman, were commonly taken in the UNIS Study Area primarily in bongo samples, and almost exclusively during fall surveys (Table 3). Wenchman larvae were distributed in a band along the 50-300 m isobaths outlining the DeSoto Canyon across the full extent of the UNIS Study Area (Figure 41). Frequency of occurrence and relative abundance in the UNIS

Study Area and gulfwide survey area were comparable (Table 5).

***Lutjanus* spp.**
(34 occurrences; 64 larvae)
Figure 42

The larvae in this taxon could be reliably identified only to genus because dorsal spine development was not far enough advanced for species-level identification. *Lutjanus* spp larvae were taken as often in bongo as in neuston samples but were nearly twice as numerous in neuston collections; all specimens were taken during fall surveys (Table 3). Most occurrences and specimens were found at localities within the 100 m isobath (Figure 42). Frequency of occurrence and relative abundance, particularly from bongo samples, was greater gulfwide than in the UNIS Study Area survey area (Table 5).

Lutjanus campechanus



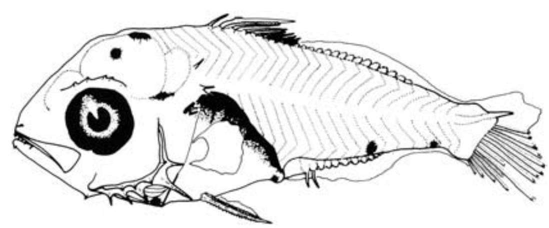
(33 occurrences; 71 larvae)
Figure 43

The larvae of the red snapper, an important resource species, were taken more often and in greater numbers in neuston than in bongo samples; and, except for one occurrence and two specimens, were all taken during fall surveys (Table 3). Red snapper larvae occurred most often and in greater numbers along or west of longitude 87º W (Figure 43). Frequency of occurrence (bongo and neuston samples) and relative abundance (bongo samples) were greater gulfwide than in the UNIS Study Area but relative abundance in neuston samples was comparable (Table 5).

Lutjanus griseus
(9 occurrences; 9 larvae)
Figure 44

Grey snapper larvae were present in both bongo and neuston collections; all occurrences except one were during fall surveys (Table 3). Larvae were almost exclusively found at localities in the eastern UNIS Study Area, along or to the east of longitude 86º W (Figure 44). Frequency of occurrence and relative abundance in the UNIS and gulfwide survey areas were comparable (Table 5).

Rhomboplites aurorubens



(174 occurrences; 644 larvae)
Figure 45

Vermilion snapper larvae were the second most frequently taken and abundant taxon of snapper larvae in the UNIS Study Area. Only specimens that could be identified only as Lutjanidae were more numerous (Table 3). Although more total specimens were collected in neuston samples, 67 percent of all occurrences resulted from bongo net samples. All but four occurrences, and 97 percent of specimens were taken during fall surveys. Vermilion snapper larvae were widely distributed through the UNIS Study Area, but were taken more consistently east of longitude 87º W (Figure 45). Larvae were taken relatively more frequently in the UNIS Study Area than gulfwide (Table 5).

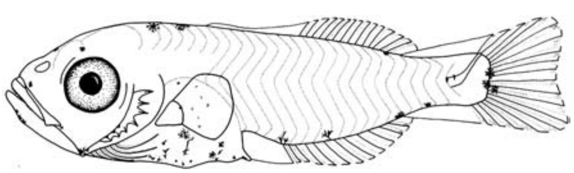
Lobotidae

Lobotes surinamensis

(23 occurrences; 39 larvae)
Figure 46

Tripletail larvae were taken only in neuston samples and primarily during fall surveys (Table 3). The two springtime occurrences were located well off the continental shelf (Figure 46). Larvae were more consistently taken and more abundant in the western region of the UNIS Study Area, along or west of longitude 87º W. Larval tripletail occurrence and relative abundance in the UNIS Study Area and gulfwide survey area were comparable (Table 5).

Haemulidae

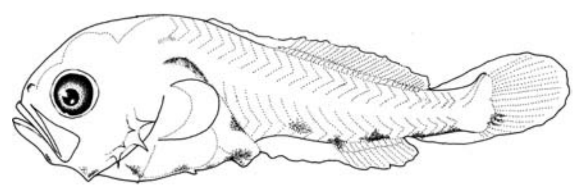


(10 occurrences; 139 larvae)
Figure 47

Grunts are important predators on offshore reefs in the GOM (Hoese and Moore 1977). Larvae hatch from pelagic eggs in a relatively undeveloped state and early stage larvae are difficult to distinguish from the larvae of many other percoid families (Leis and Rennis 1983). There is no specialized pelagic juvenile in the early life history of grunts. It appears that grunt larvae are not widely dispersed, but settle to bottom habitats within 13 to 20 days of hatching at 6.5-9.0 mm (Lindeman et al. 2001). Grunt larvae were taken mostly in bongo samples, and almost exclusively during fall surveys (Table 3). Mean size in neuston collections was 3.3 mm (n = 3, range = 2.8-3.7 mm); mean size in bongo samples was 3.5 mm (n = 6, range = 2.0-6.0 mm). Haemulidae larvae occurred three times in neuston collections between longitudes 87º and 86º W in the vicinity of the head of the DeSoto Canyon over 100 to 200 m water depth. However, most occurrences and highest mean abundances were at localities east of longitude 86º W and inshore of the 100 m isobath (Figure 47). This pattern corresponds with the general and striking absence of grunts from the list of species inhabiting Pinnacles deep reefs off Alabama and Mississippi (Weaver et al. 2002). In general, relative occurrence and abundance of grunt larvae were slightly higher in the gulfwide survey area than in the UNIS study area (Table 5).

Sciaenidae

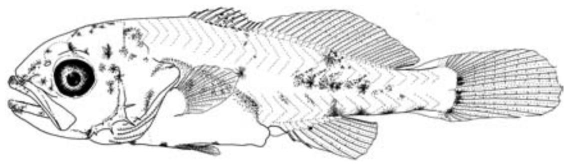
***Cynoscion* spp.**



(64 occurrences; 515 larvae)
Figure 48

In the GOM this taxon (seatrouts) included the larvae of *Cynoscion arenarius* and *C. nothus*. Although spawning is somewhat separated in time and space, the larvae of these two species of sciaenids are difficult to distinguish from each other. Over 80 percent of seatrout larvae were taken in bongo samples, mostly during fall surveys (Table 3). Larvae consistently occurred inshore of the 200 m isobath with the highest mean abundances being found inshore in the northeastern corner of the UNIS Study Area, i.e. around Cape San Blas (Figure 48). *Cynoscion* larvae occurred more frequently and were relatively more abundant gulfwide than in the UNIS Study Area (Table 5).

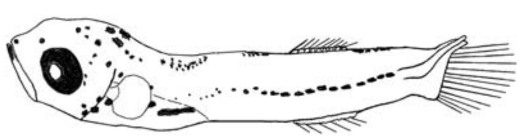
Sciaenops ocellatus



(48 occurrences; 351 larvae)
Figure 49

The larvae of this late summer to fall spawning sciaenid (the red drum) were taken in both bongo and neuston samples during fall surveys (Table 3). Along or west of longitude 87º W, red drum larvae occurred inshore of the 200 m isobath. East of longitude 87º W, larvae were found only inshore of the 50 m isobath (Figure 49). Red drum larvae occurred more frequently and were relatively more abundant gulfwide than in the UNIS Study Area (Table 5).

Mullidae



(268 occurrences; 19,855 larvae)
Figure 50

The young of these bottom-dwelling, reef-associated fishes are abundant in the surface waters of the UNIS Study Area and were among the most numerous taxa in neuston collections considered for this report. Goatfishes pass through a pelagic juvenile stage when they superficially resemble young mullet and occupy the same niche in offshore surface waters. Goatfish young were almost exclusively taken during spring surveys in the UNIS Study Area (Table 3). Larvae were distributed throughout the UNIS Study Area during spring with the highest mean abundances of 100-500 larvae per 10-min tow at two localities on the 200 m isobath between longitudes 86.5º and 86º W (Figure 50). Percent occurrence of goatfish young among all UNIS Study Area neuston samples (76%) far exceeded comparative percent occurrence gulfwide (51%). Relative abundance was 1.7 times greater in the UNIS Study Area than gulfwide (Table 5).

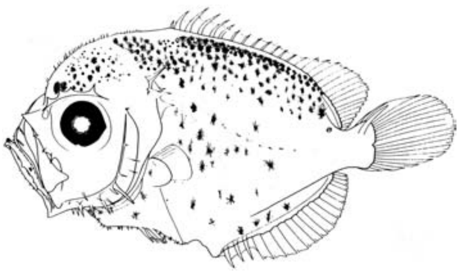
Chaetodontidae

(11 occurrences; 12 larvae)
Figure 51

Butterflyfishes are among the most characteristic inhabitants of the reef-fish fauna. Their larvae are distinctive, especially after formation of the unique bony head plates that mark their specialized, pelagic 'tholichthys' stage (Leis and Rennis 1983). Chaetodontid larvae are a rare component of plankton collections (Leis 1989). They tend to be more numerous in distant oceanic waters than near the adult reef habitat (Leis 1989). In the NEGOM study area chaetodontid larvae were slightly more common in neuston than bongo samples. Over 80 percent of occurrences and specimens were captured during fall surveys (Table 3). Mean size in neuston collections was 4.8 mm (n = 5, range = 3.0-8.2 mm); mean size in bongo samples was 3.6 mm (n = 5, range = 2.5-5.2 mm). Larvae were taken only at localities at or east of longitude 86.5º W, but were found over water depths ranging from <50 m to > 500 m (Figure 51). Butterflyfish larvae were relatively more common in the gulfwide survey area than in the UNIS Study Area, except in neuston collections during fall surveys. During fall, larvae were taken twice as frequently in the UNIS Study Area as gulfwide (Table 5).

Chaetodontid larvae were more common gulfwide during spring surveys, while in the UNIS Study Area they were more common during fall surveys.

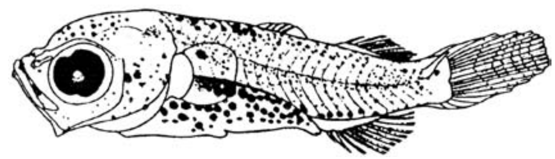
Pomacanthidae



(6 occurrences; 7 larvae)
Figure 52

Angelfishes are also characteristic members of reef communities. Their larvae, like those of the previous family, are distinctive and rare in plankton collections. However, angelfishes do not have a specialized pelagic stage. Pomacanthid larvae were taken in both neuston and bongo samples, and during spring and fall surveys. There were too few occurrences overall to compare spatial or seasonal differentiation within the UNIS Study Area (Table 3). Mean size in neuston collections was 10.1 mm (n = 4, range = 3.1-14.0 mm); mean size in bongo samples was 6.1 mm (n = 3, range = 3.8-7.2 mm). Distribution of angelfish was similar to that of butterflyfish larvae (Figure 52). Angelfish larvae were taken only at localities along or east of longitude 86.5º W and were found over water depths ranging from 50-400 m. Among all combinations of gear and survey timeframes, pomacanthid larvae were relatively more common gulfwide than in the UNIS Study Area (Table 5).

Mugilidae



(154 occurrences; 1,669 larvae)
Figure 53

As silvery pelagic juveniles, mullet inhabit surface waters of the open ocean for several months before migrating inshore. Young of the two abundant species of mullets in the GOM are likely to be present in UNIS Study Area plankton collections despite different spawning seasons. *Mugil cephalus* spawns in late fall and winter; *M. curema* spawns in spring (Ditty and Shaw 1996). Young mullets were taken almost exclusively in neuston samples during spring surveys throughout the UNIS Study Area (Table 3; Figure 53). Percent occurrence of mullet among UNIS Study Area neuston samples (47%) exceeded comparative occurrence gulfwide (31%). However, relative abundance in the UNIS Study Area and gulfwide was comparable (Table 5).

Pomacentridae

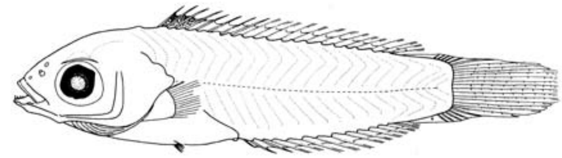
(63 occurrences; 166 larvae)
Figure 54

The damselfishes are among the most studied of the reef fishes, but the larval development of very few species has been described. The eggs of these fishes are demersal, but the larvae of most species are planktonic (Leis and Rennis 1983, Watson 1996). Identification even to the family level remains problematic for the Pomacentridae (Kavanagh et al. 2000). This is especially true in the GOM where the poorly-known larvae of mullids, gerreids and sparids are abundant. Larvae of these other perciform families closely resemble pomacentrid larvae.

For example, juvenile *Abudefduf saxatilis* were recently re-identified from re-examination of SEAMAP specimens previously identified as Sparidae (porgies) (J. Lyczkowski-Shultz, NMFS, pers. comm.). Despite uncertainties in identification, SEAMAP data on larval pomacentrid are summarized in the present report. However, this has been undertaken with the caveat that misidentifications have previously led to an underestimation of occurrence and abundance of at least one pomacentrid (J. Lyczkowski-Shultz, NMFS, pers. comm.).

Damselfish larvae were taken as often in neuston as in bongo nets; and, although the total number of specimens was equally divided between spring and fall surveys, larvae occurred three times more frequently in fall than in spring (Table 3). Mean size in neuston collections was 4.9 mm (n = 30, range = 2.5-17.8 mm); mean size in bongo samples was 2.9 mm (n = 37, range = 1.6-5.0 mm). Larvae were distributed throughout the UNIS Study Area, especially during fall surveys when highest mean abundances were found along or east of longitude 86.5º W (Figure 54). Relative abundance in the UNIS Study Area and gulfwide survey area were comparable for both gear types and survey timeframes but relative occurrence varied (Table 5). During spring surveys larvae were relatively more common gulfwide than in UNIS Study Area bongo samples. Occurrence in bongo samples during fall surveys was comparable in both study areas. Relative occurrence in neuston samples was comparable in both study areas during spring surveys, but greater gulfwide during fall surveys.

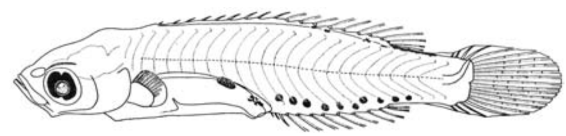
Labridae



(358 occurrences; 3,420 larvae)
Figure 55

Among specimens that could be reliably identified at least to family, larvae of the wrasses were the most numerous for characteristic reef fishes in UNIS Study Area collections. Over 80 percent of occurrences, and 93 percent of specimens, were captured in bongo samples. Fall surveys accounted for 86 percent of occurrences and 95 percent of specimens (Table 3). Mean size in neuston collections was 7.1 mm (n = 54, range = 2.0-12.6 mm); mean size in bongo samples was 5.0 mm (n = 140, range = 1.2-12.0 mm). Wrasse larvae were homogeneously distributed throughout the UNIS Study Area, being taken at nearly every locality during fall surveys (aside from one site within the IOS-NEGOM polygon, and four sites in the extreme southwestern corner of the UNIS Study Area (Figure 55). Occurrence of wrasses in UNIS Study Area samples (71%) exceeded their occurrence gulfwide (41%) during fall surveys. Relative abundance in the UNIS Study Area was also greater than gulfwide: 3.67 versus 1.22 larvae per 10 m², respectively (Table 5).

Scaridae



(113 occurrences; 369 larvae)
Figure 56

Although not as abundant as wrasse larvae, parrotfish larvae were also taken primarily in bongo net samples during fall surveys (Table 3). Mean size in neuston collections was 7.8 mm (n = 27, range = 2.1-11.7 mm); mean size in bongo samples was 5.4 mm (n = 72, range = 1.8-11.0 mm). Parrotfish larvae were not as widely distributed throughout the UNIS Study Area as were labrid larvae. Parrotfish larvae were more frequently taken and more numerous at localities east of 87º W longitude during fall surveys (Figure 56). Occurrence and relative abundance of scarid larvae in the UNIS Study Area and gulfwide survey area were comparable during fall surveys. However, during spring surveys, larvae occurred more than twice as frequently in gulfwide bongo samples as they did in UNIS Study Area samples (Table 5).

Acanthuridae

(4 occurrences; 5 larvae)
Figure 57

As in a number of other reef-fish families the duration of the pelagic phase of the surgeonfishes may be long and includes a specialized, pre-settlement stage called the 'acronurus' (Thresher 1984). These larvae were rare in the UNIS Study Area. They occurred in both bongo and neuston samples, with all but one occurrence during spring surveys (Table 3). Mean size in neuston collections was 3.6 mm (n = 3, range = 3.5-3.7 mm); mean size in bongo samples was 9.2 mm (n = 2, range = 4.0-14.3 mm). All captures were made outside the IOS-NEGOM polygon, at or beyond the continental slope (Figure 57). Larvae were relatively more common in gulfwide collections (Table 5).

Trichiuridae

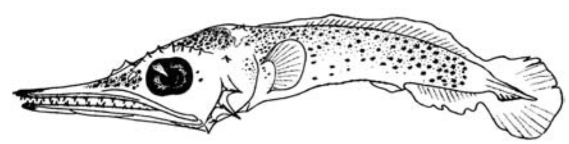
Trichiurus lepturus

(82 occurrences; 260 larvae)
Figure 58

The Atlantic cutlassfish is the most common member of the snake mackerel family in the GOM. Young *T. lepturus* were most frequently captured in bongo samples during fall surveys (Table 3). Larvae occurred more often, and in greater numbers, in the central and western regions of the UNIS Study Area (Figure 58). Atlantic cutlassfish young were never taken east of 86 º W longitude. Larvae were as common gulfwide as in UNIS Study Area collections during fall surveys, but were taken more frequently in UNIS Study Area bongo samples during spring surveys (Table 5).

Xiphiidae

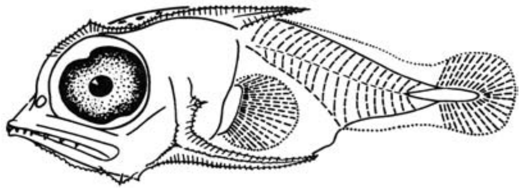
Xiphias gladius



(3 occurrences; 4 larvae)
Figure 59

Swordfish larvae were rare in the UNIS Study Area. All four specimens captured were taken in neuston samples during spring surveys, at or beyond the shelf-slope break, i.e., beyond the 200 m isobath (Table 3; Figure 59). Larvae were relatively more common in gulfwide collections. They were captured in both bongo and neuston samples during spring surveys, and in neuston samples during fall surveys (Table 5).

Istiophoridae

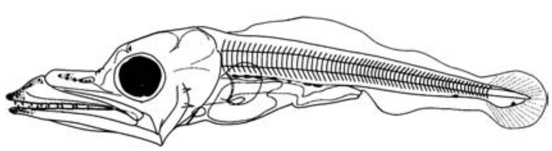


(38 occurrences; 78 larvae)
Figure 60

Billfish larvae are difficult to identify even to the genus level. However, their identity at the family level is indisputable. Most billfish young caught in the UNIS Study Area were taken in neuston samples with 67 percent of the specimens being taken during fall surveys (Table 3). There was a clear shift in the distribution of billfish larvae from offshore in the spring to more inshore during the fall survey (Figure 60). Larvae were taken most consistently during fall surveys over the 'head' and the eastern slope of the DeSoto Canyon. No billfish larvae were captured west of longitude 87.5º W during fall surveys. Frequency of occurrence was somewhat higher gulfwide (9-10%), than in the UNIS Study Area (4-6%) during both survey timeframes (Table 5).

Scombridae

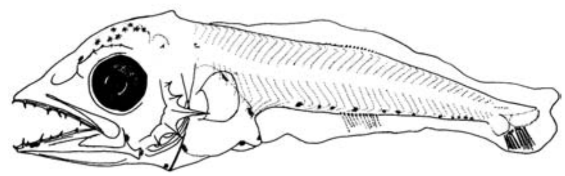
Acanthocybium solandri



(2 occurrences; 2 larvae)
Figure 61

The wahoo is another highly-prized sportfish. Its larvae were rare in the UNIS Study Area. Larvae were taken exclusively in bongo net samples during fall surveys (Table 3). Both UNIS localities where larvae were taken lie outside the IOS-NEGOM polygon (Figure 61). The westernmost capture site was located over water depths exceeding 1,500 m, whereas the easternmost capture site was located between the 50 m and 100 m isobaths. Although wahoo larvae were taken at comparable rates over the gulfwide and UNIS Study Area during fall surveys, larvae were taken only outside the UNIS Study Area survey area during SEAMAP spring surveys (Table 5).

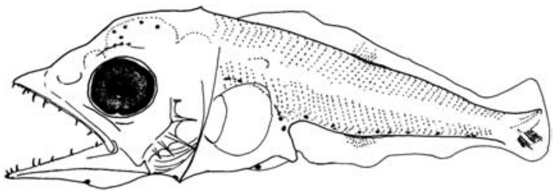
Scomberomorus cavalla



(87 occurrences; 143 larvae)
Figure 62

King mackerel larvae occurred across the UNIS Study Area inshore of the 200 m isobath, and only during fall surveys. They were captured as often in bongo as in neuston samples (Figure 62). Neuston collections however, accounted for 62 percent of specimens captured (Table 3). King mackerel larvae were taken in spring surveys gulfwide, but not in the UNIS Study Area (Table 5). Frequency of occurrence and relative abundance in neuston collections was comparable in the two survey areas during fall. However, occurrence was higher and relative abundance greater in gulfwide bongo samples.

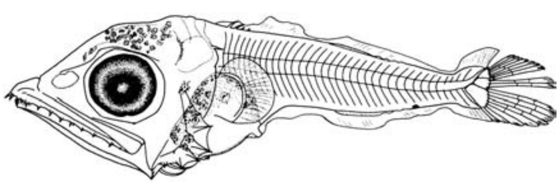
Scomberomorus maculatus



(39 occurrences; 144 larvae)
Figure 63

Spanish mackerel larvae were also taken as often in bongo as in neuston samples, with the latter gear capturing the majority of specimens. Unlike king mackerel larvae, Spanish mackerel larvae were found in the UNIS Study Area during spring surveys (Table 3). Spanish mackerel larvae were not as evenly distributed over the UNIS Study Area as were king mackerel larvae during fall surveys (Figures 55 and 56). The Spanish mackerel spawns in more nearshore areas than its congener. Spanish mackerel larvae were taken more often at localities inshore of the 50 m isobath, especially east of 87º W longitude (Figure 63). Occurrence and relative abundance of Spanish mackerel larvae were higher gulfwide during fall surveys, but were higher in the UNIS Study Area during spring surveys (Table 5).

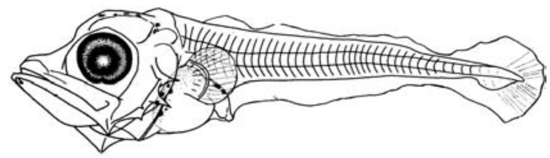
Katsuwonus pelamis



(63 occurrences; 136 larvae)
Figure 64

Larvae of this oceanic schooling scombrid were as common in bongo as in neuston samples, and during spring and fall surveys (Table 3). Skipjack tuna larvae were taken most frequently and at the highest mean abundances at localities beyond the 100 m isobath (Figure 64). Larvae occurred more frequently and were relatively more abundant gulfwide than in the UNIS Study Area during spring surveys but relative occurrence and abundance were comparable in the two survey areas during fall surveys (Table 5).

***Thunnus* spp.**



(165 occurrences; 712 larvae)
Figure 65

Tuna larvae of this genus are difficult to identify. Due to the economic importance of Atlantic bluefin tuna, *Thunnus thynnus*, all tuna larvae captured during SEAMAP spring surveys and initially identified in Poland were re-examined and their identification verified (W. J. Richards, NMFS, pers. comm.). No attempt was made to identify *Thunnus* larvae captured in fall surveys to species. Although far more numerous in neuston samples, *Thunnus* spp. larvae were taken as often in bongo as in nwuston samples (Table 3). Occurrence and abundance were higher in fall than in spring. Tuna larvae were only taken beyond the 200 m isobath during spring surveys, but were found from the 200 m to within in the 50 m isobaths during fall surveys (Figure 65). Frequency of occurrence and relative abundance of tuna larvae both within the UNIS Study Area and gulfwide varied by sampling season (Table 5). During spring surveys, *Thunnus* spp. larvae were taken more commonly, and in greater abundance, gulfwide than in the UNIS Study Area. In contrast, larval tuna catches in fall samples were comparable in the UNIS Study Area and gulfwide.

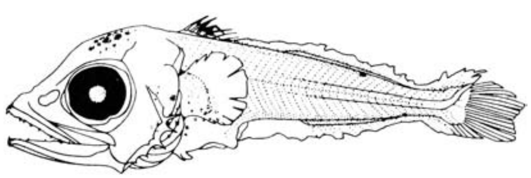
Thunnus albacares
(2 occurrences; 2 larvae)
Figure 66

Yellowfin tuna larvae were taken only twice in the UNIS Study Area (Table 3). One capture site was located over the 200 m isobath in the southeastern corner of the IOS-NEGOM polygon; while the second site was located between the 500 and 1,000 m isobaths in the head of DeSoto Canyon (Figure 66). Frequency of occurrence and relative abundance in the UNIS Study Area and gulfwide survey area were comparable (Table 5).

Thunnus atlanticus
(1 occurrence; 6 larvae)
Figure 67

Blackfin tuna larvae were taken only once in the UNIS Study Area, at a site located between the 500 and 1,000 m isobaths in the head of DeSoto Canyon (Table 3, Figure 66). Blackfin tuna larvae were taken far more commonly gulfwide (Table 5).

Thunnus thynnus



(26 occurrences; 136 larvae)
Figure 68

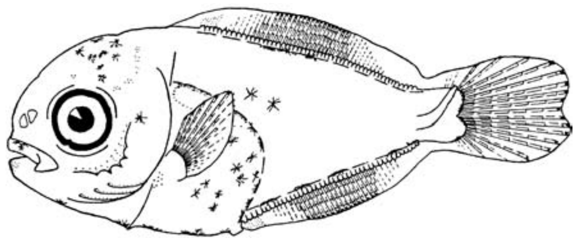
Larvae of the Atlantic bluefin tuna were the most common of the tuna larvae identified to species in the UNIS Study Area. This species is managed through international treaties governing its conservation. Annual estimates of larval abundance from SEAMAP spring plankton surveys are used in Atlantic bluefin tuna stock assessment. Atlantic bluefin tuna larvae were more frequently taken in neuston than in bongo net samples; and were only captured in spring SEAMAP sampling (Table 3). Larvae were found across the UNIS Study Area, but mean abundances were highest in the southeastern corner of the study area (Figure 68). Atlantic bluefin tuna larvae were more commonly taken and were relatively more abundant gulfwide than in the UNIS Study Area (Table 5).

Stromateidae

Peprilus alepidotus
(51 occurrences; 181 larvae)
Figure 69

Harvestfish young, like most other members of the family Stromateidae, are often found schooling under floating debris and pelagic coelenterates. Larvae were taken primarily in bongo samples; 70 percent occurrence and 75 percent of total specimens captured (Table 3). Harvestfish young were almost exclusively taken during fall surveys. Larvae were found throughout the UNIS Study Area generally within the 100 m isobath with highest mean abundances in bongo samples observed off Cape San Blas inshore of the 50 m isobath off northern Florida (Figure 69). Frequency of occurrence and relative abundance in the UNIS Study Area and in the gulfwide survey area were comparable (Table 5).

Peprilus burti



(115 occurrences; 813 larvae)
Figure 70

The Gulf butterfish is a demersal, vertically-migrating, middle to outer continental shelf species (Vecchione 1987, Herron et al. 1989). Gulf butterfish larvae were more abundant than harvestfish larvae in the UNIS Study Area. As with harvestfish larvae, Gulf butterfish larvae were more common in bongo than in neuston samples, and were taken almost exclusively during fall surveys (Table 3). Although larvae occurred throughout the UNIS Study Area, the highest mean abundances were observed at localities between the 50-200 m isobaths along the contours outlining DeSoto Canyon (Figure 70). Frequency of occurrence of Gulf butterfish larvae in bongo samples was higher in the UNIS Study Area (26%) than gulfwide (11%) (Table 5).

Discussion

The present synopsis of occurrence, abundance and distribution of the early life stages of select fishes in the northeast GOM is based on 1,166 ichthyoplankton samples from annual SEAMAP resource surveys conducted by NMFS from 1982-1999. This report represents the only such synthesis of data on fish larvae for the area between the Mississippi River and Cape San Blas, Florida. Although not designed to elucidate biological/physical coupling and recruitment dynamics, it does depict 'average conditions' of ichthyoplankton abundance and occurrence in the region based on 18 years of data. The only comparable studies of ichthyoplankton in the NEGOM region have detailed assemblage structure and seasonality, but were limited in duration (1-3 years) and were conducted in adjoining but dissimilar habitats: Mississippi Sound and adjacent coastal waters (Rakocinski et al. 1996); Loop Current boundary in open GOM waters (Richards et al. 1993); and the west Florida shelf southeast of Cape San Blas (Houde et al. 1979).

A complete representation of the seasonal occurrence and abundance of ichthyoplankton in the UNIS Study Area cannot be produced from SEAMAP data since only spring and fall data were available for analysis. However, these two periods, principally mid-April through May, and September to mid-October, encompass the spawning seasons and peak occurrence of the majority of shelf-dwelling species in the GOM (Ditty 1986, Ditty et al. 1988). Houde and Chitty (1976) found ichthyoplankton abundance to be highest on the West Florida Shelf during May through September. Of course, depending on specific taxa of interest, there are notable exceptions to this. Thus, late fall to winter spawning species, such as most groupers, tilefishes, porgies, menhaden and striped mullet, are poorly represented in available SEAMAP samples.

The UNIS Study Area contributed more fish eggs, total larvae and zooplankton to gulfwide survey totals than would be expected from the proportion of samples taken in that region. This was more evident during spring than fall surveys, and is probably related to the close proximity of UNIS Study Area survey stations to the Mississippi River and the inshore penetration of the DeSoto Canyon. Spring survey stations outside the UNIS Study Area are located in open GOM waters beyond the influence of nutrient enriched, continental shelf waters. The consistent presence of fish eggs throughout the UNIS Study Area at mean abundances exceeding 100 eggs per $10 m^2$ indicates that this is an important spawning area. Additional evidence of high spawning activity in the region comes from a survey of the entire west Florida shelf (Houde and Chitty 1976). These researchers found that the most intense spawning of fishes occurred north of 27º 15′ N latitude, i.e. the area adjoining the UNIS Study Area to the east.

During spring surveys total ichthyoplankton abundance, both in the water column and at the surface, was proportionately greater (5-9%) in the UNIS Study Area than gulfwide. During fall surveys, the reverse was true (2-6% less than expected). This latter finding is probably related to the reduced amount of shelf area in the UNIS Study Area compared to the remainder of the survey area, especially in the northwestern GOM. Zooplankton biomass was also greater in the study area, relative to the entire survey area, during both spring and fall surveys. This difference was greater (8% greater than expected) during fall surveys.

Data for only a limited number of taxa were summarized due to the inherent limitations of larval fish identifications in the taxonomically rich GOM. The 66 taxa treated herein compare to 159 species in the NEGOM deep-reef fish fauna list presented by Weaver et al. (2002) for the Mississippi-Alabama OCS Pinnacles reefs alone. Moreover, that list omits most soft-substrate and pelagic NEGOM fish species.

Other families of fishes that contain species closely linked to reef environments include the Scorpaenidae, Gobiidae, Blenniidae, Congridae, and Tetraodontidae (Sale 1991). Larvae of these highly speciose families were taken in plankton collections in the UNIS Study Area, however, data on their occurrence and abundance were not presented in this synopsis. It is premature at this time to attempt a depiction of their distributions and abundance patterns given the paucity of information on their reproduction and early life histories. Since spawning seasons are poorly known for GOM fishes, it is likely that at least some taxa in these families are winter spawners, and have not been adequately sampled by SEAMAP surveys (Ditty 1986, Ditty et al. 1988). There have been few descriptions of larval development for species in these families from the GOM, and little emphasis has been placed upon identifying the larvae of these and other non-resource taxa found in SEAMAP collections. The larvae of none of the 31 species of Scorpaenidae, and only six (5%) of the 113 species of Gobiidae occurring in the western Central Atlantic have been described (Richards 1990). The developmental stages of none of the 16 species of Tetraodontidae or the other tetraodontiform families (Diodontidae and Ostraciidae) from the GOM have been described (Lyczkowski-Shultz 2003). Moreover, these families, as well as the Gobiidae and Blenniidae, contain many non-reef fish species, the larvae of which are also taken in SEAMAP plankton samples. Leptocephali of the family Congridae, one of the largest families of eels, are among the most difficult to identify due to the wide diversity in morphological character states they exhibit (Smith 1979). For all of the above reasons, we have deferred in this synopsis from presenting data on speciose fish families containing many unresolved genus-level and species-level larval identifications. At this time, presenting such data, resolved only to the family level, would obscure, rather than clarify, the distribution patterns of individual reef-fish genera and species of priority interest in relation to USGS deep reef community structure investigations.

Comparison of the UNIS Study Area with the larger gulfwide survey area revealed that the larvae of 16 of the 66 selected taxa occurred relatively more frequently and abundantly in the UNIS Study Area than gulfwide. This comparison was based on the SEAMAP spring and fall survey timeframe and collecting gear combination that accounted for the greater number of captures. These 16 taxa were: Muraenidae, *E. teres*, Engraulidae, Sternoptychidae, Synodontidae, Paralepididae, *C. bermudensis*, Serranidae, Serraninae, Grammistinae, *Decapturus* spp., *Seriola* spp., *R. aurorubens*, Mullidae, Labridae, and *P. burti*. This list includes fishes from mesopelagic, coastal and shelf demersal, coastal and shelf pelagic, and reef-fish assemblages. This diverse mix indicates that the NEGOM in general is an important spawning and larval nursery area for many taxa of fishes. It also reflects the wide variety of habitats available in the NEGOM, ranging from shallow mud, to sand, to deep hard-bottom and deep-reef habitats, all adjoining deep oceanic waters. The relative occurrence and abundance of many of the remaining 50 NEGOM taxa analyzed from the UNIS Study Area were similar to gulfwide values. As the number of fish taxa that can be definitively identified at the larval stage increases, it seems probable that the NEGOM will prove to be of even greater importance as a spawning and nursery area.

The NEGOM appears to be important to the production of many economically valuable, resource fishes including coastal pelagic, reef, and highly migratory species (i.e., tunas and billfishes). This conclusion is supported by the consistent occurrence of their young stages in the UNIS Study Area during SEAMAP 1982-1999 surveys. Amberjack (*Seriola* spp.) and vermilion snapper (*R. aurorubens*) larvae were relatively more common in UNIS Study Area samples than gulfwide during the season of their greatest abundance. At other times, the larvae of various taxa were as common or more common in the UNIS Study Area than gulfwide, e.g., king mackerel larvae (*S. cavalla*) in neuston samples, and Spanish mackerel larvae (*S. maculatus*) during spring SEAMAP surveys. The latter finding may indicate that Spanish mackerel begins to spawn earlier in the NEGOM than elsewhere in the GOM. Gray snapper (*L. griseus*) larvae were relatively as common and as abundant in the UNIS Study Area as gulfwide in bongo net samples (the gear that captured most gray snapper larvae). In general, red snapper (*L. campechanus*) larvae were relatively more common and abundant gulfwide than in the UNIS Study Area. However, their abundance in UNIS Study Area neuston samples alone was comparable to the gulfwide value. Young dolphin (*Coryphaena* spp.) were nearly as common and abundant in the UNIS Study Area as gulfwide during spring (offshore) surveys, when they were most abundant. Seasonally, they were more common in the UNIS Study Area during fall surveys over the continental shelf. Among highly migratory species, the larvae of one of the three taxa of tunas identified to species, yellowfin tuna (*T. albacares*), were found at comparable frequencies of occurrence in the comparative survey areas during spring surveys. Occurrences of billfish (Istiophoridae), wahoo (*A. solandri*), and cobia (*R. canadum*) larvae in plankton collections are rare events anywhere. Thus, the consistent occurrence of these species in SEAMAP collections in the UNIS Study Area is noteworthy, indicating that these highly migratory fishes spawn in the NEGOM region.

Several general distribution patterns emerged from an examination of the occurrences of larvae in the UNIS Study Area. Of the 66 selected taxa, the larvae of four taxa occurred predominately west of longitude 87º W: *R. canadum*, *Caranx* spp. *L. campechanus*, and *T. lepturus*. The larvae of fourteen taxa occurred mostly at localities east of the same longitude; *S. aurita*, *E. teres*, *C. bermudensis*, Epinephelinae, Grammistinae, Priacanthidae, *Seriola* spp., *L. griseus*, Scaridae, Istiophoridae, Apogonidae, Haemulidae, Chaetodontidae, and Pomacanthidae. A number of taxa in this latter group were found predominately east of longitude 86.5º W, including *L. griseus*, Haemulidae, Chaetodontidae, and Pomacanthidae. The general absence of adult grunts, family Haemulidae in the Pinnacles reef region west of DeSoto Canyon is confirmed in Weaver et al. (2002). Thus the larval distribution pattern for this taxon, as defined from SEAMAP samples, translates into a parallel pattern in the demersal habitat. This overall differential pattern in geographic distribution of ichthyoplankton assemblages coincides with distinct changes in topography, bottom type and hydrography across the head of DeSoto Canyon. It suggests that physical/biological coupling in the NEGOM is an important determinant of fish faunal community structure regionally. Investigation of such physical/biological interaction was precisely what had been envisioned in the original concept of the MMS Integrated Oceanographic Study within the IOS-NEGOM polygon.

The northern rim of DeSoto Canyon cuts into the inner continental shelf to a minimum depth of 50-60 m dividing the NEGOM shelf into distinct western and eastern sectors subject to different physical and biological influences. Oceanographically, cold deep water, driven by the GOM Loop Current (Maul 1977), rides up the canyon impinging upon the inner shelf (Müller-Karger et al. 2001). The canyon promotes multi-layered flow conditions in the region, with eastward flow at the surface, and counter or westward flow at depth (Berger et al. 1996). Interaction between the Loop Current and DeSoto Canyon has been implicated in the formation of the episodic, high chlorophyll plume or “Green River” that flows southward along the West Florida Shelf (Gilbes et al. 1996, Gilbes et al. 2002).

Differential oceanographic processes seem to have been trenchant over geological time. Multibeam seafloor mapping, and subsequent interpretation of geology, shows major differences in geomorphology east and west of DeSoto Canyon (Gardner et al. 2000, 2001a, 2001b, 2002a, 2002b, 2003).

The sedimentology of the Mississippi-Alabama,-Florida continental shelf supports a long-standing pattern of east-west habitat differentiation in the NEGOM. Clastic sands dominate the surficial sediment sheet west of Cape San Blas, Florida (Doyle and Sparks 1980). To the east, the West Florida Shelf appears to have been cut off from a major clastic sand source since the Jurassic (Doyle and Sparks 1980); carbonate sands predominate (Pequegnat et al. 1990). Angular sand grains characterize the Mississippi-Alabama shelf west of DeSoto Canyon (Mazzullo and Peterson 1989), in a region receiving the outflow of several riverine/estuarine systems (e.g., Escambia-Blackwater-Yellow, Mobile, Pascagoula, and Mississippi systems). Rounded grains predominate to the east, where the Choctawhatchee and Apalachicola rivers are the only conduits for delivery of continental sediments onto the shelf. But, both rivers empty into estuarine embayments with seaward sediment transport limited by a series of barrier islands.

The influence of DeSoto Canyon appears profound, differentiating both the demersal (Weaver et al. 2002) and pelagic fish faunas, including current-borne ichthyoplankton. The SEAMAP distribution patterns for larvae of six taxa clearly coincide with the 50-500 isobaths outlining the submarine canyon: *C. bermudensis*, Sternoptychidae, Paralepididae, Anthiine, and *P. aquilonaris*. The distribution of larval *P. burti* was also linked to the canyon, but deviated somewhat from this pattern. Highest mean abundances were consistently located over the canyon although Gulf butterfish larvae also occurred inshore of the canyon.

Although discrete depth sampling was not conducted during SEAMAP surveys, the two types of plankton nets employed provided samples from distinct and separate segments of the water column. The neuston net sampled the upper half-meter of the ocean surface layer. The bongo net sampled the entire water column from sub-surface to near bottom (or to a maximum depth of 200 m when bottom depth was greater). Contrasting the catches of the two gear types provided some insights into utilization of two different oceanic regimes by fish larvae in the UNIS Study Area. The young of 11 taxa, including highly migratory, pelagic, and reef fishes, were found predominantly in the surface layer of the ocean: *X. gladius*, Istiophoridae, *T. thynnus*, *R. canadum*, *Caranx* spp., *Seriola* spp., Coryphaenidae, *L. surinamensis*, Muraenidae, Holocentridae, and Mullidae. For these taxa, over 85 percent of specimens were taken in surface waters, and over 70 percent of captures occurred in surface waters. The young of *X. gladius*, *R. canadum*, and *L. surinamensis* were never captured below the surface layer (i.e., never in bongo nets). All remaining taxa considered in this report were as numerous, or more numerous, below the surface layer (i.e., in bongo net collections) as at the surface (i.e., in neuston net collections). Among the young of hard-bottom and deep-reef fishes analyzed from UNIS Study Area collections, six were found principally below the surface layer, occurring in over 70 percent of bongo samples: *C. bermudensis*, Anthiinae, Epinephelinae, Haemulidae, Labridae and Scaridae. Except for the Anthiinae, over 90 percent of specimens in these taxa were taken in the water column. In the Anthiinae, 69 percent of specimens were taken in the water column. The young of three additional hard/live bottom taxa; Priacanthidae, Pomacentridae and Acanthuridae, occurred with equal frequency in both surface and water column collections.

Limited size data were summarized for the young of 16 taxa representing fishes living in or near hard/live bottom habitats. These taxa included members of the five subfamilies of sea basses (Serranidae) and the remaining ten families of characteristic reef fishes (Table 3). Due to the difficulties inherent in these data (i.e. not all larvae in collections were measured), only incidence of the largest specimens relative to position in the water column and the incidence of smallest larvae were examined. There seemed to be a difference in the size of larvae captured in the surface layer and throughout the water column for some reef taxa. The largest individuals of three taxa were consistently taken in neuston samples. This was most evident for young Holocentridae, but also true for young Priacanthidae and Pomacentridae. The early life histories of the first two families are known to include a pelagic juvenile stage of long duration prior to settlement (Thresher 1984). Early life stages of representatives of all three families, especially the pomacentrid *Abudefduf saxatilis*, are consistently taken in floating *Sargassum* in the western Atlantic Ocean and NEGOM (Dooley 1972, Bortone et al. 1977, Moser et al. 1998, Franks et al. 2002). The size distributions of the most ubiquitous and numerous reef fishes in UNIS Study Area SEAMAP plankton collections, the Labridae and Scaridae, were essentially the same in both surface and water column collections. Among sea bass larvae, larger anthiines were taken in water column samples, while individuals in the largest size classes of the Serranine and Grammistinae were equally represented in both surface and water column collections.

The relatively high densities of fish eggs found during SEAMAP surveys indicate that the NEGOM is an important spawning area for fishes in general. The presence of very early larvae in the 1.5-2.0 mm size classes is further evidence of local spawning. Small sea bass larvae in those size classes were collected in the UNIS Study Area, indicating unambiguously that these fishes spawn in the NEGOM region. Larvae ≤ 2.0 mm were also present in seven of the ten selected reef-fish families. The smallest larvae of the Chaetodontidae, Pomacanthidae, and Acanthuridae taken in UNIS Study Area samples were 2.5, 3.1, and 3.5 mm, respectively.

The small number of specimens captured for these taxa makes it difficult to determine unequivocally if local spawning does occur. Quantifying the UNIS Study Area contribution of sea bass or reef-fish spawning, for comparative contrast with gulfwide production is not currently feasible. All or most archived SEAMAP larvae would have to be re-examined and measured in order to calculate the abundance of larvae within size classes. Once this had been achieved, quantitative regional comparisons of the smallest size class of larvae retained in SEAMAP samples could be undertaken.

Local spawning, however, may not be the only source of reef-fish larvae in NEGOM waters. The Loop Current and its associated eddies and rings are known to exert the dominant dynamic influence not only in the open GOM, but also on the continental shelf and slope; and facilitate exchanges of water mass between them (Maul 1977, Vukovich and Crissman 1986, Kelly 1991, Hamilton 1992, Berger et al. 1996, Nowlin et al. 1998). The UNIS Study Area is consistently in the direct path of the Loop Current. The shelf edge region off Mississippi and Alabama is influenced by the Loop Current 40 percent of the time (Kelly 1991). Additionally, pools of Loop Current water formed by short-lived rings can intrude into the UNIS Study Area at least as often as every 2 years (Müller-Karger et al. 2001). It is probable that the early life stages of hard/live bottom fishes are periodically transported into the UNIS Study Area via Loop Current intrusions, providing an extrinsic source of recruitment. However, larvae produced in the UNIS Study Area may either be retained there, or exported to other GOM reefs via the same transport mechanisms. Hanisko and Lyczkowski-Shultz (2003) examined the distribution of labrid and scarid larvae from SEAMAP collections relative to the Loop Current and its associated eddies and rings. These authors suggest that, depending on species-specific planktonic stage durations, larvae produced on reefs throughout the northern GOM could be entrained in Loop Current eddies and could return in time to settle on their natal reefs, or, alternatively, could be exported to settle on distant GOM reefs.

This synopsis represents an examination of the most extensive set of ichthyoplankton data available for the GOM. The specific purpose of this synthesis of SEAMAP ichthyoplankton data was to characterize occurrence and abundance of young fishes in the northeastern GOM region, and to ascertain the NEGOM region's relative importance in the early life history of fishes as compared to the entire Gulf of Mexico within the U.S. EEZ. Despite the obvious shortcomings of SEAMAP data (i.e., inconsistencies in precision of taxonomic identification for larvae of all species), this summary has revealed that the northeastern GOM must be considered an important, if not essential habitat, for the young of a diverse assemblage of fish larvae. The varied and juxtaposed habitats available to adult fishes in the NEGOM result in an area favorable to spawning and nursery functions for a wide diversity of estuarine and coastal, hard/live bottom, soft bottom, and oceanic fishes. This synopsis is the precursor to more focused investigations designed to reveal linkages among the diverse biotopes of the NEGOM from an ontogenetic perspective. Subsequent analyses of SEAMAP data will address relevant questions concerning larval fish production and recruitment within the NEGOM.

Recommendations and New Research Directions

Many gaps in our knowledge of ontogeny and early life history of marine fishes in the GOM were revealed through this synthesis of SEAMAP ichthyoplankton data. The fact that larvae of many key groups of fishes have not been identified to species is the major impediment identified. This limitation precludes utilization of SEAMAP collections to describe critical spawning and nursery habitats and relationships between oceanographic processes and pre-settlement stage larvae. It limits attempts to understand recruitment dynamics and the effects of perturbations to the environment.

However, previously published and new descriptions of larval development will soon become available in a manual for the identification of the eggs, larvae and juveniles of marine fishes from the western central North Atlantic Ocean (W. J. Richards, NMFS, in preparation). Completed chapters by family are now available online (http://www4.cookman.edu/NOAA) and also appear on the NOAA SEFSC website (http://www.sefsc.noaa.gov). It is now feasible, therefore, to re-examine larvae of selected taxa housed at the SEAMAP Archive and potentially resolve their identification to lower taxonomic levels. The chapter on one important hard/live bottom family, the Serranidae, is completed. Its use for re-examination of sea bass larvae will allow researchers to more precisely describe the early life histories of these key members of hard/live bottom communities on the of NEGOM OCS (Richards 1999).

Two additional recommendations for further ichthyoplankton research in the GOM lie in the realm of additional survey coverage and directed sampling. The original plan to sample throughout the GOM covering all regions (open GOM and entire continental shelf) in all seasons was never accomplished. As a result, there are major gaps in data and information for species that spawn in areas and at times that remain un-surveyed. The most notable deficiency is the lack of information on winter-spawning species. This includes the groupers, porgies, mullets, and tilefishes, taxa containing many economically important species. Presumably, many of the species most closely linked to the OCS hard-bottom and deep reef communities in the NEGOM spawn during winter months. Colin and Clavijo (1988) have reported that off southwestern Puerto Rico, most species of fishes, even those with protracted spawning seasons, exhibit peak spawning in winter months. Latitudinal shifts in the timing of spawning have been documented for reef fishes, but there is little comparative data on this phenomenon for GOM species (Robertson 1991). It is unlikely that an extensive and intensive schedule of winter surveys could be conducted on an annual basis, but biennial or triennial winter surveys would represent a major step forward in eventually developing a more comprehensive set of larval distribution and abundance data for all marine fishes in the GOM. Another major data gap is the lack of information on the vertical distribution of fish larvae and their distribution relative to major oceanographic features (i.e., the Loop Current and its system of eddies and rings). Position in the water column can have a direct influence on dispersal of fish larvae (Lyczkowski-Shultz and Steen 1991). Moreover, the pre-settlement and pelagic juvenile stages of many reef fishes are capable of adjusting their vertical position in the water column, to potentially maintain a preferred depth (Cowan and Sponaugle 1997, Leis et al. 1996). Subsurface currents may be an important mechanism for either the local retention of larvae, or their transport to the distant locations where they will eventually settle and take up the adult habitat. Ichthyoplankton sampling in the GOM relative to Loop Current fronts and associated convergence zones has shown that the larvae of tunas, wrasses and parrotfishes are more abundant in areas dominated by these oceanographic features (Richards et al. 1989, Hanisko and Lyczkowski-Shultz 2003). Additional sampling of this kind would undoubtedly reveal more detail in the physical/biological coupling between oceanographic processes and recruitment, both for reef-fish species and for estuarine/coastal species (e.g., mullet and menhaden) that spawn in open GOM waters and depend upon larval return to nearshore habitats (Richards and Lindeman 1987).

Acknowledgments

The present synopsis of SEAMAP data is a joint contribution to scientific knowledge by USGS and NMFS. It was enabled by interagency funding from the USGS Outer Continental Shelf Studies Program, and was initiated and facilitated by USGS scientists from the Coastal Ecology and Conservation Research Group, Gainesville, Florida. The Gulf Region Office of the MMS played a pivotal role in identifying the need for such a synopsis. Editor for reports in this series is Kenneth J. Sulak, USGS. Visual graphic images, including the CEC Research Group logo were prepared by Jana M. Miller, Visual Graphics Specialist, USGS.

With respect to ichthyoplankton processing and identification, the NMFS principal investigators gratefully acknowledge the significant contributions of these individuals: Rosanne Brasher, Connie Cowan and Pam Bond of the NOAA/NMFS Mississippi Laboratories, Pascagoula, Mississippi; the Ichthyoplankton Group, especially Malgorzata Konieczna, and Hanna Skolska, at the Sea Fisheries Institute, Plankton Sorting and Identification Center, Szczecin and Gdynia, Poland, and Kim Williams at the SEAMAP Archiving Center, Florida Marine Research Institute, St. Petersburg, Florida. The NMFS principal investigators would also like to recognize the enduring efforts of the crews of the NOAA Ships *Chapman*, *Oregon II* and *Gordon Gunter,* and the dedication of the field biologists of the NMFS, Gulf states resource agencies, and Johnson Controls Inc., who participated in SEAMAP cruises, creating the long time series of larval data that enabled this synopsis.

USGS investigators gratefully acknowledge the critical peer review and comment of John Caruso, University of New Orleans; R. Allen Brooks, USGS; William J. Richards and Michael P. Fahay, NMFS; Bruce Comyns, Gulf Coast Research Laboratory, and John Olney, Virginia Institute of Marine Science. The revised manuscript was greatly improved accordingly.

Outline drawings to illustrate the text were obtained from either original sources, with the permission of authors, or from public domain U.S. Government publications. Image credits are listed after the References section below.

Metadata

The official SEAMAP ichthyoplankton program database is maintained on Oracle® database software at the NOAA/NMFS Southeast Fisheries Science Center, Miami Laboratory. Data information or access requests should be directed to:

Mark McDuff, SEAMAP Data Manager
NMFS Mississippi Laboratories
Pascagoula Facility
3209 Frederic St.
Pascagoula, MS 39568
228-762-4591 x278
Mark.McDuff@noaa.gov

Data summaries for this synopsis, Project "usgsunis" were generated by scripts written in SAS Version 8.2® by David S. Hanisko, project data manager. Mapping of UNIS spatial data was accomplished using ArcView 3.X® GIS software. Information requests concerning the GIS component project should be directed to:

David S. Hanisko
NMFS Mississippi Laboratories
Pascagoula Facility
3209 Frederic St.
Pascagoula, MS 39568
228-762-4591 x204
David.S.Hanisko@noaa.gov

A fully detailed description of spatial summary methods used in the this report is presented in the GIS Companion Project Report:

Hanisko, D. S., and J. Lyczkowski-Shultz. 2004. Characterization of ichthyoplankton within the U.S. Geological Survey's northeastern Gulf of Mexico study area: A GIS companion project, 24 pp.

This companion project report is available from the Florida Integrated Science Center Website at http://cars.er.usgs.gov/coastaleco/, or in Microsoft Word® or Adobe® .pdf format upon request to David S. Hankisko.

References

Ahlstrom, E. H., and H. G. Moser. 1981. Systematics and development of early life history stages of marine fishes: achievements during the past century, present status and suggestions for the future. Rapports et Proces-Verbaux des Réunions du Conseil International pour Exploration de la Mer 178:541-546.

Berger, T. J., P. Hamilton, J. J. Singer, and R. R. Leben. 1996. Louisiana/Texas Shelf Physical Oceanography Program: eddy circulation study, final synthesis report. OCS Study MMS 96-0051. United States Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.

Bortone, S. A., P. A. Hastings, and S. B. Collard. 1977. The pelagic-*Sargassum* ichthyofauna of the eastern Gulf of Mexico. Northeast Gulf Science 1:60-67.

Colin, P. L., and I. E. Clavijo. 1988. Spawning activity of fishes producing pelagic eggs on a shelf edge coral reef, southwestern Puerto Rico. Bulletin of Marine Science 43:249-279.

Cowan, R. K., and S. Sponaugle. 1997. Relationships between early life history traits and recruitment among coral reef fishes. Pages 423-449 *in* C. Chambers and E. A. Trippel, editors. Early life history and recruitment in fish populations. Chapman and Hall, London, UK.

Ditty, J. G. 1986. Ichthyoplankton in neritic waters of the northern Gulf of Mexico off Louisiana: composition, relative abundance, and seasonality. Fishery Bulletin 84:935-946.

Ditty, J. G., and R. F. Shaw. 1996. Spatial and temporal distribution of larval striped mullet (*Mugil cephalus*) and white mullet (*M. curema*, Family: Mugilidae) in the northern Gulf of Mexico, with notes on mountain mullet, *Agonostomus monticola*. Bulletin of Marine Science 59:271-288.

Ditty, J. G., G. C. Zieske, and R. F. Shaw. 1988. Seasonality and depth distribution of larval fishes in the northern Gulf of Mexico above latitude 26°00′ N. Fishery Bulletin 86:811-823.

Dooley, J. K. 1972. Fishes associated with the pelagic *Sargassum* complex, with discussion of the *Sargassum* community. Contributions in Marine Science 16:1-32.

Doyle, L. J., and T. N. Sparks. 1980. Sediments of the Mississippi, Alabama, and Florida

(MAFLA) continental shelf. Journal of Sedimentary Petrology 1980:905-916.

Franks, J. S., B. R. Comyns, J. R. Hendon, E. R. Hoffmayer, R. S. Waller, N. M. Crochet, and M. E. Blake. 2002. Investigation of juvenile fishes that utilize Sargassum and frontal zones as essential habitat in Mississippi waters and adjacent Gulf waters. Final Report to the Mississippi Department of Marine Resources and the U.S. Fish. and Wildlife Service. Contact No. 067-C-Sargassum. Gulf Coast Research Laboratory, Ocean Springs, MS.

Gardner, J. V., K. J. Sulak, P. Dartnell, L. Hellequin, B. Calder, and L. A. Mayer. 2000. The bathymetry and acoustic backscatter of the Pinnacles area, northern Gulf of Mexico. U.S. Geological Survey Open-File Report 2000-350, 35 pp.

Gardner, J. V., P. Dartnell, K. J. Sulak, B. Calder, and L. Hellequin. 2001a. Physiography and late Quaternary-Holocene Processes of northeastern Gulf of Mexico outer continental shelf off Mississippi and Alabama. Gulf of Mexico Science 2001:132-157.

Gardner, J. V., L. A. Mayer, J. E. Hughes Clarke, P. Dartnell, and K. J. Sulak. 2001b. The bathymetry and acoustic backscatter of the mid shelf and upper slope off Panama City, Florida, northeastern Gulf of Mexico. Cruise Report, RV *Moana Wave*, Cruise M1-01-GM, September 3, through October 12, 2001. U.S. Geological Survey Open-File Report 2001-448, 60 pp.

Gardner, J. V., P. Dartnell, and K. J. Sulak. 2002a. Multibeam mapping of the West Florida Shelf, Gulf of Mexico. U.S. Geological Survey Open-File Report OF02-5, CD-ROM; online at: http://geopubs.wr.usgs.gov/openfile/of02-5.

Gardner, J. V., P. Dartnell, and K. J. Sulak. 2002b. Multibeam mapping of the Pinnacles Region, Gulf of Mexico. U.S. Geological Survey Open-File Report OF02-6, CD-ROM; online at: http://geopubs.wr.usgs.gov/openfile/of02-6.

Gardner, J. V., J. E. Hughes Clark, L. A. Mayer, and P. Dartnell. 2003. Bathymetry and acoustic backscatter of the mid and outer continental shelf, head of DeSoto Canyon, Northeastern Gulf of Mexico – Data, images, and GIS. USGS Open-File Report OF03-007, CD-ROM; online at: http://geopubs.wr.usgs.gov/openfile/OF03-007.

Gilbes, F., F. E. Müller-Karger, and C. E. Del Castillo, 2002. New evidence for the West Florida Shelf Plume. Continental Shelf Research 22:2479-2496.

Gilbes, F., C. Tomas, J. J. Walsh, and F. E. Müller-Karger. 1996. An episodic chlorophyll plume on the West Florida Shelf. Continental Shelf Research 16:1201-1224.

Hamilton, P. 1992. Lower continental slope cyclonic eddies in the central Gulf of Mexico. Journal of Geophysical Research 97(C2):2185-2200.

Hanisko, D. S., and J. Lyczkowski-Shultz. 2003. Occurrence and pelagic habitat of reef fish larvae in the Gulf of Mexico. Pages 205-224 *in* D. R. Stanley and A. Scarborough-Bull, editors. Fisheries, reefs, and offshore development. American Fisheries Society, Symposium 36, Bethesda, MD.

Herron, R. C., T. D. Leming, and J. Li. 1989. Satellite-detected fronts and butterfish aggregations in the northeastern Gulf of Mexico. Continental Shelf Science 9:569-588.

Hoese, H. D. and R. H. Moore 1977. Fishes of the Gulf of Mexico – Texas, Louisiana, and Adjacent Waters. Texas A&M University Press, College Station, TX.

Houde, E. D., and N. Chitty. 1976. Seasonal abundance and distribution of zooplankton, fish eggs, and fish larvae in the eastern Gulf of Mexico, 1972-74. NOAA Technical Report NMFS SSRF-701.

Houde, E. D., J. G. Leak, C. E. Dowd, S. A. Berkeley, and W. J. Richards. 1979. Ichthyoplankton abundance and diversity in the eastern Gulf of Mexico. Report to the Bureau of Land Management. Contract No. AA550-CT7-28.

Kavanagh, K. D., J. M. Leis, and D. S. Rennis. 2000. Pomacentridae (Damselfishes). Pages 526-535. *in* J. M. Leis and B. M. Carson-Ewart, editors. The larvae of Indo-Pacific coastal fishes: an identification guide to marine fish larvae. Fauna Malesiana Handbook 2, Brill, The Netherlands.

Kelly, F. J. 1991. Physical oceanography, *in* J. M. Brooks, and C. P. Giammona, editors. Mississippi-Alabama continental shelf ecosystem study data summary and synthesis. United States Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, OCS Study MMS 91-0062, New Orleans, Louisiana.

Kendall, A. W., Jr., and A. C. Matarese. 1994. Status of early life history descriptions of marine teleosts. Fishery Bulletin 92:725-736.

Kramer, D., M. J. Kalin, E. G. Stevens, J. R. Thrailkill, and J. R. Zweifel. 1972. Collecting and processing data on fish eggs and larvae in the California Current region. NOAA Technical Report. NMFS Circular 370, 38 pp.

Leis, J. M., H. P. A. Sweatman, and S. E. Reader. 1996. What the pelagic stages of coral reef fishes are doing out in blue waters: daytime field observations of larval behavioural capabilities. Marine and Freshwater Research 47:401-411.

Leis, J. M., and D. S. Rennis. 1983. The larvae of Indo-Pacific coral reef fishes. New South Wales University Press, Sydney and University of Hawaii Press, Honolulu.

Lindeman, K. C., T. N. Lee, W. D. Wilson, R. Claro, and J. S. Ault. 2001. Transport of larvae originating in southwest Cuba and the Dry Tortugas: evidence for partial retention in grunts and snappers. Proceedings of the Gulf & Caribbean Fisheries Institute 52:732-747.

Leis, J. M. 1989. Larval biology of butterfly-fishes (Pisces, Chaetodontidae): what do we really know? Environmental Biology of Fishes 25(1-3):87-100.

Ludwick, J.C. and W.R Walton. 1957. Shelf edge, calcareous prominences in the northeastern Gulf of Mexico. Bulletin of the American Association of Petroleum Geologists 41:2054-2101.

Lyczkowski-Shultz. 2003. Preliminary guide to the identifications of the early life stages of the tetraodontid fishes of the western central North Atlantic. NOAA Technical Memorandum, NMFS-SEFSC-494.

Lyczkowski-Shultz, J., M. Konieczna, and W. J. Richards. 2000. Occurrence of the larvae of beryciform fishes in the Gulf of Mexico. Bulletin of the Sea Fisheries Institute 3(151):55-66.

Lyczkowski-Shultz, J., and J.P. Steen, Jr. 1991. Diel vertical distribution of red drum *Sciaenops ocellatus* larvae in the north central Gulf of Mexico. Fishery Bulletin 89:631-641.

Maul, G. A. 1977. The annual cycle of the Gulf Loop Current, part I: observations during a one-year time series. Journal of Marine Research 35:29-47.

Mazzullo, J. and M. Peterson. 1989. Sources and dispersal of late Quaternary silt on the northern Gulf of Mexico continental shelf. Marine Geology 86:15-26.

Moser, M. L., P. J. Auster, and J. B. Bichy. 1998. Effects of mat morphology on large *Sargassum*-associated fishes: observations from a remotely operated vehicle (ROV) and free-floating video camcorders. Environmental Biology of Fishes 51:391-398.

Müller-Karger, F. E., F. Vukovich, R. Leben, B. Nababan, C. Hu, and D. Myhre. 2001. Surface circulation and the transport of the Loop Current into the northeastern Gulf of Mexico: Final Report. OCS Study MMS 2001-102, United States Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.

Nowlin, W. D., Jr., A. E. Jochens, R. O. Reid, and S. F. DiMarco. 1998. Texas-Louisiana shelf circulation and transport processes study: synthesis report, volume I: technical report. United States Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, OCS Study MMS 98-0035, New Orleans, Louisiana.

Pequegnat, W. E., B. J. Gallaway, and L. H. Pequegnat. 1990. Aspects of the ecology of the deep-water fauna of the Gulf of Mexico. American Zoologist 30:45-64.

Posgay, J. A. and R. R. Marak. 1980. The MARMAP bongo zooplankton samplers. Journal of Northwest Atlantic Fisheries Science 1: 9-99.

Rakocinski, C. F., J. Lyczkowski-Shultz, and S.L. Richardson. 1996. Ichthyoplankton assemblage structure in Mississippi Sound as revealed by canonical correspondence analysis. Estuarine, Coastal and Shelf Science 43:237-257.

Rester, J. K., N. Sanders, Jr., D .S. Hanisko, and B. Pellegrin. (editors) 2000. SEAMAP Environmental and Biological Atlas of the Gulf of Mexico, 1998. No. 75. Gulf States Marine Fisheries Commission, Ocean Springs, MS.

Richards, W. J. 1990. List of the fishes of the western central Atlantic and the status of early life stage information. NOAA Technical Memorandum NMFS-SEFC-267.

Richards, W. J. 1999. Preliminary guide to the identification of the early life history stages of serranid fishes of the western central Atlantic. NOAA Technical Memorandum NMFS-SEFSC-419.

Richards, W. J. (editor) (in preparation). Early stages of fishes from the western central North Atlantic. CRC Press, Boca Raton, FL.

Richards, W. J., and K. C. Lindeman. 1987. Recruitment dynamics of reef fishes: planktonic processes, settlement, and demersal ecologies, and fishery analysis. Bulletin of Marine Science 41:392-410.

Richards, W. J., T. Leming, M. F. McGowan, J. T. Lamkin, and S. Kelley-Fraga. 1989. Distribution of fish larvae in relation to hydrographic features of the Loop Current boundary in the Gulf of Mexico. Pages 169-176 *in* J. H. S. Blaxter, J. C. Gamble, and H. V. Westernhagen, editors. The Early Life History of Fish. Rapports et Proces-Verbaux des Réunions du Conseil International pour l'Exploration de la Mer 191.

Richards, W. J., M. F. McGowan, T. Leming, J. T. Lamkin, and S. Kelley. 1993. Larval fish assemblages at the Loop Current boundary in the Gulf of Mexico. Bulletin of Marine Science 53:475-537.

Robertson, D. R. 1991. The role of adult biology in the timing of spawning of tropical reef fishes. Pages 356-386 *in* P. F. Sale, editor, The ecology of fishes on coral reefs. Academic Press, New York, NY.

Sale, P. F. 1991. Introduction. Pages 3-11 *in* P. F. Sale, editor. The ecology of fishes on coral reefs. Academic Press, New York, NY.

Smith, D. G. 1979. Guide to the leptocephali (Elopiformes, Anguilliformes and Notacanthiformes). NOAA Technical Report, NMFS Circular No. 424.

Smith, P. E. and S. L. Richardson (editors). 1977. Standard techniques for pelagic fish egg and larva surveys. FAO Fisheries Technical Paper 175.

Sulak, K. J., D. C. Weaver, and S. W. Ross. 2000. Fish community structure: Mississippi/ Alabama Pinnacle Trend. Pages 194-203 *in*

M. McKay and J. Nides, editors. Proceedings: Eighteenth Gulf of Mexico Information Transfer Meeting, Kenner, LA, December 1998, U.S. Department of the Interior, Minerals Management Service, OCS Study MMS 2000-030.

Thresher, R. E. 1984. Reproduction in reef fishes. T. F. H. Publications, Inc., Neptune City, NJ.

Thurman, P, R. McBride, G. D. Dennis, III, and K. J. Sulak. 2003 (in press). Age and reproduction in three reef-dwelling serranid fishes of the Northeastern Gulf of Mexico Outer Continental Shelf: *Pronotogrammus martinicensis*, *Hemanthias vivanus* & *Serranus phoebe* (with preliminary observations on the Pomacentrid fish, *Chromis enchrysurus*. USGS Outer Continental Shelf Studies Program Report USGS/OCS/CSC No. 2003-02, December 2003, available in CD-ROM format and online in .ftp format at: http://cars.er.usgs.gov/coastaleco/

Vecchione, M. 1987. Commercial fishing for Gulf butterfish, *Peprilus burti*, in the Gulf of Mexico. Marine Fisheries Review 49:14-22.

Vukovich, F. M., and B. W. Crissman. 1986. Aspects of warm rings in the Gulf of Mexico. Journal of Geophysical Research. 91(C2): 2645-2660.

Watson, W. 1996. Pomacentridae: Damselfishes. Pages 1054-1063 *in* Moser, H. G., editor, The early life stages of fishes in the California Current region. California Cooperative Oceanic Fisheries Investigations Atlas (33):1509 pp.

Weaver, D. C., K. J. Sulak, W. Smith-Vaniz, and S. W. Ross. 1999. Community structure and trophic relationships of demersal reef fishes of the Mississippi-Alabama outer continental shelf. Pages 286-292 *in* M. McKay and J. Nides, editors. Proceedings Seventeenth Gulf of Mexico Information Transfer Meeting, Kenner, LA, December 1997, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, OCS Study MMS 99-0042.

Weaver, D. C., and K. J. Sulak. 2000. Trophic subsidies in the twilight zone: Food web structure of deep reef fishes along the Mississippi-Alabama outer continental shelf. Pages 203-208 *in* M. McKay and J. Nides, editors. Proceedings: Eighteenth Gulf of Mexico Information Transfer Meeting, Kenner, LA, December 1998, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, OCS Study MMS 2000-030.

Weaver, D. C. G. D. Dennis III, and. K. J. Sulak. 2002. Community structure and trophic ecology of demersal fishes on the Pinnacles Reef tract. U.S. Department of the Interior, U.G. Geological Survey Biological Sciences Report USGS BSR 2001-0008; Minerals Management Service, OCS Study MMS-2002-034.

References & Credits for Larval Fish Drawings in Text

(by order of occurrence in text)

Elopidae: Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of the egg, larval and juvenile stages. Vol. I: Acipenseridae through Ictaluridae. Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, University of Maryland. Prepared for U.S. Fish and Wildlife Service. FWS/OBS-78/12. U.S. Government Printing Office, Washington: p 49, Fig. 18B.

Muraenidae: Smith, D. G. 1979. Guide to the Leptocephali (Elopiformes, Anguilliformes, and Notacanthiformes). NOAA Technical Report NMFS Circular 424: p 20, Fig. 28A.

Brevoortia spp.: Original illustration by W. A. Laroche.

Etrumeus teres: Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Op. Cit.: p 135, Fig. 79D.

Harengula jaguana: Houde, E. D., W. J. Richards, V. P. Saksena. 1974. Description of eggs and larvae of scaled sardine, *Harengula jaguana*. Fishery Bulletin 72:1106-1122: (Redrawn by M. P. Fahay).

Opisthonema oglinum: Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Op. Cit.: p 141, Fig. 83A.

Sardinella aurita: Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Op. Cit.: p 149; Fig. 89A.

Engraulidae: Original illustration by W. A. Laroche.

Sternoptychidae: Richards, W. J. 2001. Preliminary Guide to the Identification of the Early Life History Stages of Stomiiform Fishes of the Western Central Atlantic. NOAA Technical Memorandum NMFS-SEFSC-450: p 51A.

Synodontidae: Jones, P. W., F. D. Martin, and J. D. Hardy, Jr. 1978. Op. Cit.: p 190, Fig. 108B.

Bregmacerotidae: Original illustration by Claire Ulanoff.

Melamphaidae: Keene, M. J. and K. A. Tighe. 1984. Beryciformes: Development and Relationships. Pages 383-392 *in* Ontogeny and systematics of fishes. American Society of Ichthyology and Herpetology, Special. Publication 1, H. G. Moser, W. H. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, jr., and S. L. Richardson, editors: p 387, Fig. 206E.

Holocentridae: Richards, W. J., J. Lyczkowski-Shultz, and M. Konieczna. 2003. Preliminary Guide to the Identification of the Early Life History Stages of Beryciform Fishes of the Western Central North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-499: p 24, Fig. Holocentridae 1 (B).

Serraninae: Kendall Jr., A. W. 1979. Morphological Comparisons of North American Sea Bass Larvae (Pisces: Serranidae). NOAA Technical Report NMFS Circular 428: p 5, Fig. 3B.

Anthiinae: Kendall Jr., A. W. 1979. Op. Cit.: p 20, Fig. 19A.

Epinephelinae: Original illustration by D. M. Drass.

Grammistinae: Kendall Jr., A. W. 1979. Op. Cit.: p 41, Fig. 39.

Priacanthidae: Powell, A. B. 2000. Preliminary Guide to the Identifcation of the Early Life History Stages of Priacanthid Fishes of the Western Central Atlantic. NOAA Technical Memorandum NMFS-SEFSC-439: Fig. Priacanthidae 1 (4.5 mm specimen).

Apogonidae: Original illustration by J. Javech.

Rachycentron canadum: Ditty, J. G. and R. F. Shaw. 1992. Larval development, distribution, and ecology of cobia *Rachycentron canadum* (Family: Rachycentridae) in the northern Gulf of Mexico. Fishery Bulletin 90:668-677: p 670, Fig. 2D.

Caranx spp., *Chloroscombrus chrysurus*, *Decapterus* spp., *Selar crumenophthalmus*, *Selene* spp., *Seriola* spp., *Trachinotus* spp., *Trachurus lathami*: Original illustrations by W. A. Laroche.

Coryphaenidae: Johnson, G. D. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of the egg, larval and juvenile stages. Vol. IV: Carangidae through Ephippidae. Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, University of Maryland. Prepared for U.S. Fish and Wildlife Service. FWS/OBS-78/12. U.S. Government Printing Office, Washington: p 125, Fig. 78D.

Lutjanidae: Original illustration by J. Lyczkowski-Shultz.

Pristipomoides aquilonaris: Original illustration by J. Javech.

Lutjanus campechanus: Original illustration by D. M. Drass.

Rhomboplites aurorubens: Laroche, W. A. 1977. Description of Larval and Early Juvenile Vermilion Snapper, *Rhomboplites aurorubens*. Fishery Bulletin 75: 547-554: p 549: Fig. 1B.

Haemulidae: Potthoff, T., S. Kelley, M. Moe, and F. Young. 1984. Description of Porkfish Larvae (*Anisotremus virginicus*, Haemulidae) and Their Osteological Development. Bulletin of Marine Science 34:21-59: p 26, Fig 4 (lateral view).

Cynoscion spp. *Sciaenops ocellatus*: Original illustration by W. A. Laroche.

Mullidae: Original illustration by T. Farooqi.

Pomacanthidae: Richards, W. J. 1990. List of the Fishes of the Western Central Atlantic and the Status of Early Life Stage Information. NOAA Technical Memorandum NMFS-SEFC-267: p 60, Fig. 23.

Mugilidae: Ditty, J. G., T. Farooqi, and R. F. Shaw. 2000. Preliminary guide to the identification of the early life stages of mullet (Pisces: Mugilidae) from the western Central Atlantic. NOAA Technical Memorandum NMFS-SEFSC-424: p 6E.

Labridae: Richards, W. J. 1990. List of the Fishes of the Western Central Atlantic and the Status of Early Life Stage Information. NOAA Technical Memorandum NMFS-SEFC-267: p 35, Fig. 5.

Scaridae: Richards, W. J. 1990. Op. Cit.: p 65, Fig. 29.

Trichiurus lepturus, *Xiphias gladius*, Istiophoridae, *Acanthocybium solandri, Scomberomorus cavalla, Scomberomorus maculatus, Katsuwonus pelamis, Thunnus* spp., *Thunnus thynnus.* Fritzsche, R. A. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of the egg, larval and juvenile stages. Vol. V: Chaetodontidae through Ophidiidae. Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, University of Maryland. Prepared for U.S. Fish and Wildlife Service. FWS/OBS-78/12. U.S. Government Printing Office, Washington: p 58, Fig. 22C; p 199, Fig. 115C; p 173, Fig 100B; p 67, Fig. 23D; p 123, Fig. 67C; p 129, Fig. 72B; p 93, Fig. 44C; p 145, Fig. 83E; p 165, Fig. 98A.

Peprilus burti: Ditty, J. G. 1981. Comparative morphological development of *Peprilus burti, P. triacanthus*, and *P. paru* from the western North Atlantic. Master of Science Thesis, Louisiana State University.

List of Tables

Table 1. The 36 SEAMAP plankton cruises (1982–1999) used to characterize ichthyoplankton in the UNIS Study Area. Two survey time frames are represented: open GOM spring surveys (April to June), and fall surveys (August to mid-October) on the continental shelf.

Vessel and Cruise	Year	Sampling Dates	Time Frame
Oregon II 126	1982	04/15 to 05/06	Spring
Oregon II 134	1983	04/22 to 05/10	Spring
Oregon II 143	1984	04/24 to 04/28	Spring
Oregon II 146	1984	08/02 to 08/27	Fall
Oregon II 159	1986	04/22 to 05/21	Spring
Oregon II 161	1986	09/04 to 09/08	Fall
Oregon II 166	1987	04/18 to 05/20	Spring
Oregon II 169	1987	09/12 to 09/17	Fall
Oregon II 173	1988	04/20 to 05/26	Spring
Oregon II 176	1988	09/07 to 09/28	Fall
Albatross IV 892	1989	04/28 to 05/19	Spring
Oregon II 183	1989	09/26 to 09/29	Fall
Oregon II 187	1990	04/20 to 05/24	Spring
Chapman 904	1990	05/30 to 06/24	Spring
Oregon II 190	1990	09/02 to 09/07	Fall
Oregon II 194	1991	04/17 to 05/08	Spring
Chapman 914	1991	09/16 to 09/26	Fall
Oregon II 199	1992	04/22 to 05/12	Spring
Chapman 925	1992	09/16 to 09/20	Fall
Oregon II 201	1992	09/24 to 09/27	Fall
Chapman 934	1993	04/26 to 05/05	Spring
Oregon II 204	1993	05/19 to 06/15	Spring
Chapman 936	1993	09/26 to 09/29	Fall
Oregon II 207	1993	10/05 to 10/06	Fall
Oregon II 209	1994	04/28 to 05/05	Spring
Chapman 946	1994	09/20 to 09/29	Fall
Oregon II 216	1995	04/19 to 05/31	Spring
Chapman 955	1995	09/17 to 09/26	Fall
Oregon II 220	1996	04/17 to 05/18	Spring
Chapman 965	1996	09/13 to 09/25	Fall
Oregon II 225	1997	04/17 to 06/09	Spring
Chapman 975	1997	09/15 to 09/27	Fall
Chapman 984	1998	04/19 to 05/20	Spring
Gordon Gunter 981	1998	09/22 to 09/24	Fall
Oregon II 234	1999	04/23 to 05/22	Spring
Gordon Gunter 992	1999	09/15 to 09/29	Fall

Table 2. The 72 unique localities or sites used to characterize ichthyoplankton within the UNIS Study Area. Key: S = spring survey, F = fall survey.

Sampling Locality	Central Latitude	Central Longitude	Mean Depth (m)	Time Frame	Spring Bongo Samples	Spring Neuston Samples	Fall Bongo Samples	Fall Neuston Samples
A160	85.5	28.5	198	S/F	4	24	1	1
A165	86.0	29.0	245	S	26	26	0	0
B001	88.0	29.0	1,364	S/F	29	29	1	1
B002	87.0	29.0	692	S	33	30	0	0
B140	84.5	29.5	22	F	0	0	10	10
B141	84.5	29.0	33	S/F	1	1	8	11
B142	84.5	28.5	48	S/F	1	1	10	10
B143	84.5	28.0	74	F	0	0	7	9
B153	85.0	28.0	248	S/F	23	22	7	7
B154	85.0	28.5	98	S/F	2	2	9	11
B155	85.0	29.0	37	S/F	1	1	11	11
B156	85.0	29.5	12	F	0	0	6	8
B157	85.5	29.8	19	F	0	0	9	12
B158	85.5	29.5	13	F	0	0	12	12
B159	85.5	29.0	69	S/F	1	1	9	13
B160	85.5	28.7	175	S/F	0	1	9	10
B161	85.5	28.0	569	S	2	2	0	0
B164	86.0	28.5	337	S	4	28	0	0
B165	86.0	29.2	187	S/F	1	1	13	13
B166	86.0	29.5	56	F	0	0	9	13
B167	86.0	30.0	30	F	0	0	13	13
B168	86.5	30.0	55	F	0	0	15	15

Table 2 (continued).

Sampling Locality	Central Latitude	Central Longitude	Mean Depth (m)	Time Frame	Spring Bongo Samples	Spring Neuston Samples	Fall Bongo Samples	Fall Neuston Samples
B169	86.5	29.5	206	S/F	2	20	9	13
B170	86.5	29.0	378	S	3	26	0	0
B171	87.0	29.5	406	S	1	1	0	0
B172	87.0	30.0	70	S/F	3	20	11	14
B173	87.5	30.0	26	F	0	0	12	13
B174	87.5	29.5	77	F	0	0	11	14
B175	87.5	29.0	1,609	S/F	2	4	1	1
B176	88.0	29.5	45	S/F	1	16	10	10
B177	88.0	30.0	23	S/F	1	1	10	10
B178	88.5	30.0	24	F	0	0	7	8
B179	88.5	29.5	49	F	0	0	10	10
B180	88.5	29.0	625	S/F	2	11	2	2
B253	86.5	28.5	591	S	1	1	0	0
B318	86.5	30.3	21	F	0	0	11	15
B319	87.0	30.3	20	F	0	0	14	14
B320	87.0	29.8	192	F	0	0	14	15
B321	87.5	30.3	12	F	0	0	11	13
B322	88.0	29.3	236	S/F	1	1	12	13
B323	88.5	29.2	118	F	0	0	11	14
U001	88.5	29.8	33	F	0	0	1	1
U002	88.5	28.8	1,345	F	0	0	1	1
U003	88.3	30.0	27	F	0	0	1	1
U004	88.3	29.8	37	F	0	0	1	1

Table 2 (continued).

Sampling Locality	Central Latitude	Central Longitude	Mean Depth (m)	Time Frame	Spring Bongo Samples	Spring Neuston Samples	Fall Bongo Samples	Fall Neuston Samples
U005	88.3	29.5	48	F	0	0	1	1
U006	88.3	29.3	95	F	0	0	1	1
U007	88.3	29.0	1,014	F	0	0	1	1
U008	88.3	28.8	1,620	F	0	0	1	1
U009	88.0	29.8	37	F	0	0	1	1
U010	87.5	29.8	37	F	0	0	1	1
U011	87.5	29.3	1,007	S	1	1	0	0
U012	87.0	30.2	26	F	0	0	1	1
U013	86.6	29.3	360	S	2	2	0	0
U014	86.5	29.8	119	F	0	0	1	1
U015	86.3	29.7	77	S	2	2	0	0
U016	86.2	28.3	611	S	2	2	0	0
U017	86.0	30.3	18	F	0	0	1	1
U018	86.0	30.2	26	F	0	0	1	1
U019	86.0	29.8	41	F	0	0	2	2
U020	85.7	28.9	186	S	2	2	0	0
U021	85.5	29.2	64	F	0	0	1	1
U022	85.5	28.3	307	F	0	0	1	0
U023	85.5	29.7	22	F	0	0	1	1
U024	85.1	27.8	430	F	0	0	1	0
U025	85.0	29.4	20	F	0	0	1	2
U026	85.0	28.2	167	F	0	0	4	4
U027	84.8	28.8	48	F	0	0	1	1

Table 2 (continued).

Sampling Locality	Central Latitude	Central Longitude	Mean Depth (m)	Time Frame	Spring Bongo Samples	Spring Neuston Samples	Fall Bongo Samples	Fall Neuston Samples
U028	84.5	29.8	13	F	0	0	1	1
U029	84.5	29.3	29	F	0	0	1	1
U030	84.5	28.3	62	F	0	0	1	1
U031	84.5	27.8	110	F	0	0	1	1

Table 3: Ichthyoplankton data for 66 selected fish taxa analyzed from the UNIS Study Area. Data include number of occurrences recorded and number of specimens collected in bongo and neuston samples during SEAMAP spring and fall plankton surveys, 1982-1999. Reef-associated species, and higher taxa including characteristically reef-associated species are denoted in bold font.

Taxon	Total Occ	Total Number Specimens	Sampling Gear				Survey Time Frame			
			Bongo		Neuston		Spring		Fall	
			Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens
Acanthuridae	4	5	2	2	2	3	3	4	1	1
Apogonidae	169	579	98	342	71	237	58	175	111	404
Bregmacerotidae	441	9,918	371	9,474	70	444	182	2,933	259	6,985
Carangidae										
Caranx spp.	183	1,449	37	91	146	1,358	90	812	93	637
Chloroscombrus chyrsurus	206	14,916	98	1,217	108	13,699	1	8	205	2,908
Decapturus spp.	479	7,101	226	3,832	253	3,269	60	397	419	6,704
Selar crumenophthalmus	99	710	54	122	45	588	4	4	95	706
Selene spp.	34	53	17	28	17	25	0	0	34	53
***Seriola* spp.**	123	461	8	12	115	449	80	385	43	76
Trachinotus spp.	46	85	0	0	46	85	32	60	14	25
Trachurus lathami	16	61	6	17	10	44	16	61	0	0
Carapidae	22	62	21	61	1	1	5	6	17	56
Carapus bermudensis	68	210	38	210	0	0	8	11	60	199
Chaetodontidae	11	12	4	5	7	7	2	2	9	10
Clupeidae	371	11,541	155	3,348	216	8,193	108	4,031	263	7,510
Brevoortia spp.	1	1	0	0	1	1	1	1	0	0
Etrumeus teres	56	1,306	31	354	25	952	53	1,303	3	3
Harengula jaguana	137	3,909	30	140	107	3,769	47	2,440	90	1,469
Opisthonema oglinum	89	1,163	50	794	39	369	10	223	79	940
Sardinella aurita	148	4,360	67	1,616	81	2,744	8	35	140	4,325

Table 3 (continued).

Taxon	Total Occ	Total Number Specimens	Sampling Gear				Survey Time Frame			
			Bongo		Neuston		Spring		Fall	
			Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens
Coryphaenidae	187	438	27	37	160	401	109	281	78	157
Elopidae	7	16	3	5	4	11	0	0	7	16
Engraulidae	573	40,732	283	15,345	290	25,387	97	3,100	476	37,632
Haemulidae	10	139	7	136	3	3	2	2	8	137
Holocentridae	23	34	5	5	18	29	10	17	13	17
Istiophoridae	38	78	4	7	34	71	13	27	25	51
Labridae	358	3,420	288	3,180	70	240	50	165	308	3,255
Lobotidae										
Lobotes surinamensis	23	39	0	0	23	39	2	2	21	37
Lutjanidae	190	728	162	668	28	60	8	8	182	720
Pristipomoides aquilonaris	74	208	51	124	23	84	5	6	69	202
Lutjanus spp.	34	64	18	23	16	41	0	0	34	64
Lutjanus campechanus	33	71	10	14	23	57	1	2	32	69
Lutjanus griseus	9	9	6	6	3	3	1	1	8	8
Rhomboplites aurorubens	174	644	114	318	60	326	4	21	170	623
Melamphaidae	58	90	51	82	7	8	41	66	17	24
Mugilidae	154	1,669	15	36	139	1633	144	1,647	10	22
Mullidae	268	19,855	31	91	237	19,764	241	19,651	27	204
Muraenidae	83	188	23	29	60	159	12	21	71	167
Paralepididae	215	1,053	196	1,028	19	25	130	775	85	278
Pomacanthidae	6	7	2	3	4	4	4	4	2	3

Table 3 (continued).

Taxon	Total Occ	Total Number Specimens	Sampling Gear				Survey Time Frame			
			Bongo		Neuston		Spring		Fall	
			Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens
Pomacentridae	63	166	33	90	30	76	16	82	47	84
Priacanthidae	109	239	55	102	54	137	18	57	91	182
Rachycentronidae										
Rachycentron canadum	5	21	0	0	5	21	3	17	2	4
Sciaenidae										
Cynoscion spp.	64	515	42	412	22	103	4	19	60	496
Sciaenops ocellatus	48	351	32	243	16	108	0	0	48	351
Scaridae	113	369	90	331	23	38	28	39	85	330
Scombidae										
Acanthocybium solandri	2	2	2	2	0	0	0	0	2	2
Scomberomorus cavalla	87	143	44	55	43	88	0	0	87	143
Scomberomorus maculatus	39	144	19	39	20	105	12	85	27	59
Katsuwonus pelamis	63	136	36	60	27	76	34	66	29	70
Thunnus spp.	171	727	81	200	90	527	45	209	126	518
Thunnus albacares	2	2	1	1	1	1	2	2	0	0
Thunnus atlanticus	1	6	0	0	1	6	1	6	0	0
Thunnus thynnus	26	136	7	13	19	123	26	136	0	0
Serranidae	320	1,415	263	1,272	57	143	88	317	232	1,098
Anthiinae	72	182	56	126	16	56	43	112	29	70
Grammistinae	117	215	78	143	39	72	17	41	100	174
Epinephelinae	3	5	3	5	0	0	3	5	0	0
Liopropomatinae	1	1	0	0	1	1	1	1	0	0

Table 3 (continued).

Taxon	Total Occ	Total Number Specimens	Sampling Gear				Survey Time Frame			
			Bongo		Neuston		Spring		Fall	
			Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens	Occ	Number Specimens
Serraninae	236	1,672	150	1,118	86	554	54	235	182	1,437
Sternoptychidae	210	3,533	204	3,411	6	122	122	2,310	88	1,223
Stromateidae										
Peprilus alepidotus	51	181	36	136	15	45	1	1	50	180
Peprilus burti	115	813	92	721	23	92	8	20	107	793
Synodontidae	501	7,229	360	6,497	141	732	140	1,253	361	5,976
Trichiuridae										
Trichiurus lepturus	82	260	69	222	13	38	16	62	66	198
Xiphiidae										
Xiphias gladius	3	4	0	0	3	4	3	4	0	0

Table 4. The number of UNIS Study Area samples, summed abundance of fish eggs and total fish larvae, and summed plankton displacement volume expressed as a percent of the corresponding totals for gulfwide surveys all samples combined during SEAMAP spring and fall plankton surveys, 1982-1999. Abundance from bongo samples = # larvae under 10 m^2 sea surface. Abundance from neuston samples = # larvae per 10- min tow. Plankton displacement volume = ml per 10 m^2.

Data Category	Number of Samples			Summed Abundance		
	Gulfwide Surveys	UNIS Area	% NEGOM/Gulfwide	Gulfwide Surveys	UNIS Area	% UNIS/Gulfwide
Fish Eggs						
Spring Bongo	939	100	11	225,138.8	46,658.5	21
Fall Bongo	836	176	21	354,986.8	71,708.2	20
Total Larvae						
Spring Bongo	1,453	154	11	1,328,800.6	208,493.9	16
Spring Neuston	2,290	279	12	194,334.1	41,242.8	21
Fall Bongo	1,591	345	22	1,998,674.1	399,675.5	20
Fall Neuston	1,766	388	22	356,974.1	56,908.5	16
Displacement Volume						
Spring Bongo	1,449	153	11	180,899.6	22,803.2	13
Fall Bongo	1,549	332	21	130,575.6	36,962.9	28

Table 5. Comparison of SEAMAP ichthyoplankton sampling data (selected taxa, 1982-1999) from the UNIS Study Area versus gulfwide (GOM). Taxa are arranged in order of treatment in text. Abundance data from bongo samples is standardized as the number of larvae under $10m^2$ sea surface. Abundance from neuston samples is standardized as the number of larvae per 10-min tow. Summary data include: OCC = number of samples in which a given taxon occurred by study area (upper number), and percent of samples containing a given taxon among all study area samples (lower number in parenthesis); SUM = sum of standardized abundance data by taxon and sampling area (upper number), and the same sum by taxon as percent of overall sum for all taxa by sampling area (lower number in parenthesis). Non-integers below 100 are rounded to nearest 0.1; non-integers above 100 to the nearest integer.

Taxon	Spring Survey								Fall Survey							
	Bongo				Neuston				Bongo				Neuston			
	GOM		UNIS		GOM		UNIS		GOM		UNIS		GOM		UNIS	
	OCC	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**
Elopidae	4 (0.3)	35.9 (0.0)	0 (0.0)	0 (0.0)	8 (0.4)	13.0 (0.0)	0 (0.0)	0 (0.0)	13 (0.8)	76.9 (0.0)	3 (0.9)	25.8 (0.0)	14 (0.8)	27.2 (0.0)	4 (1.0)	11.0 (0.0)
Muraenidae	36 (2.5)	210 (0.0)	2 (1.3)	13.6 (0.0)	81 (3.5)	146 (0.1)	10 (3.6)	19.4 (0.0)	103 (6.5)	522 (0.0)	21 (6.1)	131.6 (0.0)	161 (9.1)	502 (0.1)	50 (12.9)	141 (0.2)
Clupeidae	171 (11.8)	9737 (0.7)	41 (26.6)	2413 (1.2)	240 (10.5)	6750 (3.5)	67 (24.0)	3581 (8.7)	804 (50.5)	169226 (8.5)	114 (33.0)	8234 (2.1)	926 (52.4)	67463 (18.9)	149 (38.4)	4614 (8.1)
Brevoortia spp.	1 (0.1)	6.0 (0.0)	0 (0.0)	0 (0.0)	5 (0.2)	13.0 (0.0)	1 (0.4)	1.0 (0.0)	3 (0.2)	17.1 (0.0)	0 (0.0)	0 (0.0)	5 (0.3)	18.0 (0.0)	0 (0.0)	0 (0.0)
Etrumeus teres	118 (8.1)	5120 (0.4)	29 (18.8)	1833 (0.9)	52 (2.3)	1102 (0.6)	24 (8.6)	951 (2.3)	7 (0.4)	45.9 (0.0)	2 (0.6)	8.7 (0.0)	3 (0.2)	3.1 (0.0)	1 (0.3)	1.1 (0.0)
Harengula jaguana	26 (1.8)	576 (0.0)	6 (3.9)	322 (0.2)	136 (5.9)	3315 (1.7)	41 (14.7)	2383 (5.8)	223 (14.0)	6116 (0.3)	24 (7.0)	333 (0.1)	442 (25.0)	11816 (3.3)	66 (17.0)	1385 (2.4)
Opisthonema oglinum	15 (1.0)	378 (0.0)	5 (3.2)	180 (0.1)	12 (0.5)	250 (0.1)	5 (1.8)	193 (0.5)	508 (31.9)	80780 (4.0)	45 (13.0)	1679 (0.4)	403 (22.8)	26858 (7.5)	34 (8.8)	176 (0.3)
Sardinella aurita	25 (1.7)	3501 (0.3)	1 (0.6)	6.1 (0.0)	62 (2.7)	1916 (1.0)	7 (2.5)	34.0 (0.1)	346 (21.8)	68539 (3.4)	66 (19.1)	4618 (1.16)	370 (21.0)	23814 (6.7)	74 (19.1)	2713 (4.8)
Engraulidae	191 (13.2)	17801 (1.3)	36 (23.4)	3460 (1.7)	243 (10.6)	6348 (3.3)	61 (21.9)	2467 (6.0)	988 (62.1)	202438 (10.1)	247 (71.6)	56420 (14.1)	859 (48.6)	100446 (28.1)	229 (59.0)	23188 (40.8)
Sternoptychidae	992 (68.3)	59385 (4.5)	117 (76.0)	12548 (6.0)	22 (1.0)	180 (0.1)	5 (1.8)	121 (0.3)	290 (18.2)	19132 (1.0)	87 (25.2)	6547 (1.6)	6 (0.3)	6.8 (0.0)	1 (0.3)	1.0 (0.)
Synodontidae	510 (35.1)	37776 (2.8)	83 (53.9)	4872 (2.3)	233 (10.2)	1673 (0.9)	57 (20.4)	362 (0.9)	1050 (66.0)	97158 (4.9)	277 (80.3)	25893 (6.5)	336 (19.0)	2460 (0.7)	84 (21.6)	376 (0.7)
Paralepididae	1023 (70.4)	23245 (1.8)	115 (74.7)	4405 (2.1)	120 (5.2)	210 (0.1)	15 (5.4)	21.0 (0.0)	299 (18.8)	4663 (0.2)	81 (23.5)	1490 (0.4)	8 (0.4)	7.7 (0.0)	4 (1.0)	3.8 (0.0)
Bregmacerotidae	1165 (80.2)	107491 (8.1)	142 (92.2)	14661 (7.0)	149 (6.5)	1332 (0.7)	40 (14.3)	308 (0.8)	926 (58.2)	165835 (8.3)	229 (66.4)	33850 (8.5)	105 (6.0)	274 (0.1)	30 (7.7)	136 (0.2)

Table 5 (continued).

Taxon	Spring Survey								Fall Survey							
	Bongo				Neuston				Bongo				Neuston			
	GOM		UNIS		GOM		UNIS		GOM		UNIS		GOM		UNIS	
	OCC	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**
Carapidae	24 (1.6)	147 (0.0)	5 (3.2)	35.0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	40 (2.5)	618 (0.0)	16 (4.6)	320 (0.1)	1 (0.1)	1.0 (0.0)	1 (0.3)	1.0 (0.0)
Carapus bermudensis	63 (4.3)	463 (0.0)	8 (5.2)	63.9 (0.0)	1 (0.0)	0.9 (0.0)	0 (0.0)	0 (0.0)	157 (9.9)	2349 (0.1)	60 (17.4)	984 (0.2)	3 (0.2)	3.1 (0.0)	0 (0.0)	0 (0.0)
Melamphaidae	481 (33.1)	4846 (0.4)	36 (23.4)	367 (0.2)	22 (1.0)	41.9 (0.0)	5 (1.8)	6.0 (0.0)	87 (5.5)	642 (0.0)	15 (4.4)	121 (0.0)	5 (0.3)	4.9 (0.0)	2 (0.5)	2.0 (0.0)
Holocentridae	70 (4.8)	874 (0.1)	1 (0.6)	5.7 (0.0)	175 (7.6)	1007 (0.5)	9 (3.2)	17.3 (0.0)	53 (3.3)	423 (0.0)	4 (1.2)	22.4 (0.0)	71 (4.0)	166 (0.0)	9 (2.3)	13.5 (0.0)
Serranidae	452 (31.1)	17180 (1.3)	61 (39.6)	1320 (0.6)	206 (9.0)	766 (0.4)	27 (9.7)	59.5 (0.1)	778 (48.9)	16690 (0.8)	202 (58.6)	4035 (1.0)	123 (7.0)	329 (0.1)	30 (7.7)	82.2 (0.1)
Serraninae	247 (17.0)	3559 (0.3)	22 (14.3)	279 (0.1)	161 (7.0)	754 (0.4)	32 (11.5)	184 (0.4)	561 (35.3)	13429 (0.7)	128 (37.1)	3492 (0.9)	225 (12.7)	2563 (0.7)	54 (13.9)	371 (0.6)
Anthiinae	269 (18.5)	6040 (0.4)	30 (19.5)	366 (0.2)	89 (3.9)	349 (0.2)	13 (4.7)	53.0 (0.1)	69 (4.3)	864 (0.0)	26 (7.5)	344 (0.1)	7 (0.4)	44.0 (0.0)	3 (0.8)	3.0 (0.0)
Epinephelinae	27 (1.9)	461 (0.0)	3 (2.0)	27.4 (0.0)	2 (0.1)	3.0 (0.0)	0 (0.0)	0 (0.0)	5 (0.3)	48.9 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Liopropomatinae	7 (0.5)	39.1 (0.0)	0 (0.0)	0 (0.0)	5 (0.2)	11.0 (0.0)	1 (0.4)	1.0 (0.0)	5 (0.3)	26.6 (0.0)	0 (0.0)	0 (0.0)	3 (0.2)	4.5 (0.0)	0 (0.0)	0 (0.0)
Grammistinae	68 (4.7)	525 (0.0)	7 (4.6)	88.1 (0.0)	64 (2.8)	97.1 (0.0)	10 (3.6)	26.9 (0.1)	280 (17.6)	2011 (0.1)	71 (20.6)	528 (0.1)	131 (7.4)	334 (0.1)	29 (7.5)	44.1 (0.1)
Priacanthidae	78 (5.4)	751 (0.1)	6 (3.9)	165 (0.1)	97 (4.2)	238 (0.1)	12 (4.3)	28.0 (0.1)	226 (14.2)	2120 (0.1)	49 (14.2)	358 (0.1)	177 (10)	932 (0.3)	42 (10.8)	108 (0.2)
Apogonidae	200 (13.8)	1676 (0.1)	23 (14.9)	196 (0.1)	164 (7.2)	470 (0.2)	35 (12.5)	143 (0.4)	456 (28.7)	7989 (0.4)	75 (21.7)	1143 (0.3)	206 (11.7)	1022 (0.3)	36 (9.3)	96.9 (0.2)
Rachycentron canadum	3 (0.2)	23.3 (0.0)	0 (0.0)	0 (0.0)	18 (0.8)	35.0 (0.0)	3 (1.1)	17.0 (0.0)	3 (0.2)	21.8 (0.0)	0 (0.0)	0 (0.0)	55 (3.1)	134 (0.4)	2 (0.5)	4.0 (0.0)
Caranx spp.	249 (17.1)	7151 (0.5)	19 (12.3)	364 (0.2)	907 (39.6)	11224 (5.8)	71 (25.4)	767 (1.9)	157 (9.9)	1390 (0.1)	18 (5.2)	152 (0.0)	437 (24.8)	2691 (0.8)	75 (19.3)	605 (1.1)
Chloroscombrus chrysurus	4 (0.3)	22.6 (0.0)	0 (0.0)	0 (0.0)	13 (0.6)	66.0 (0.0)	1 (0.4)	8.0 (0.0)	716 (45.0)	89025 (4.4)	98 (28.4)	3290 (0.8)	779 (44.1)	33405 (9.4)	107 (27.6)	1685 (3.0)
Decapturus spp.	108 (7.4)	1893 (0.1)	11 (7.1)	114 (0.0)	277 (12.1)	1273 (0.7)	49 (17.6)	378 (0.9)	619 (38.9)	37449 (1.9)	215 (62.3)	13826 (3.5)	561 (31.8)	9134 (2.6)	204 (52.6)	2929 (5.2)

Table 5 (continued).

Taxon	Spring Survey								Fall Survey							
	Bongo				Neuston				Bongo				Neuston			
	GOM		UNIS		GOM		UNIS		GOM		UNIS		GOM		UNIS	
	OCC	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**
Selar crumenophthalmus	37 (2.6)	457 (0.0)	2 (1.3)	13.5 (0.0)	84 (3.7)	225 (0.1)	2 (0.7)	2.0 (0.0)	259 (16.3)	4333 (0.2)	52 (15.1)	539 (0.1)	207 (11.7)	1338 (0.4)	42 (10.8)	586 (1.0)
Selene spp.	7 (0.5)	60.4 (0.0)	0 (0.0)	0 (0.0)	12 (0.5)	17.0 (0.0)	0 (0.0)	0 (0.0)	175 (11.0)	2188 (0.1)	17 (4.9)	141 (0.0)	96 (5.4)	252 (0.1)	17 (4.4)	24.8 (0.0)
Seriola spp.	52 (3.6)	471 (0.0)	5 (3.2)	53.3 (0.0)	478 (20.9)	1508 (0.8)	75 (26.9)	376 (0.9)	37 (2.3)	214 (0.0)	3 (0.9)	11.3 (0.0)	182 (10.3)	348.20 (0.1)	40 (10.3)	72.8 (0.1)
Trachinotus spp.	4 (0.3)	23.03 (0.0)	0 (0.0)	0 (0.0)	197 (8.6)	341 (0.2)	32 (11.5)	60.0 (0.2)	1 (0.1)	3.0 (0.0)	0 (0.0)	0 (0.0)	94 (5.3)	147 (0.0)	14 (3.6)	24.8 (0.0)
Trachurus lathami	36 (2.5)	408 (0.0)	6 (3.9)	102 (0.0)	64 (2.8)	205 (0.1)	10 (3.6)	44.0 (0.11)	8 (0.5)	64.7 (0.0)	0 (0.0)	0 (0.0)	5 (0.3)	6.9 (0.0)	0 (0.0)	0 (0.0)
Coryphaenidae	176 (12.1)	1357 (0.1)	15 (9.7)	128 (0.1)	901 (39.4)	2508 (1.3)	94 (33.7)	260 (0.6)	46 (2.9)	234 (0.0)	12 (3.5)	70.9 (0.0)	264 (15.0)	513 (0.14)	66 (17.0)	144 (0.2)
Lutjanidae	60 (4.1)	757 (0.1)	5 (3.2)	32.2 (0.0)	22 (1.0)	81.0 (0.0)	3 (1.1)	3.0 (0.0)	675 (42.4)	14166 (0.7)	157 (45.5)	2654 (0.7)	111 (6.3)	368 (0.1)	25 (6.4)	57.0 (0.1)
Pristipomoides aquilonaris	29 (2.0)	211 (0.0)	4 (2.6)	25.6 (0.0)	24 (1.0)	55.5 (0.0)	1 (0.4)	1.8 (0.0)	222 (14.0)	3408 (0.2)	47 (13.6)	618 (0.2)	115 (6.5)	512 (0.14)	22 (5.7)	82.2 (0.1)
Lutjanus spp.	15 (1.0)	106 (0.0)	0 (0.0)	0 (0.0)	21 (0.9)	41.0 (0.0)	0 (0.0)	0 (0.0)	231 (14.5)	2122 (0.1)	18 (5.2)	112 (0.0)	149 (8.4)	953 (0.3)	16 (4.1)	40.9 (0.1)
Lutjanus campechanus	4 (0.3)	28.8 (0.0)	0 (0.0)	0 (0.0)	15 (0.7)	51.0 (0.0)	1 (0.4)	2.0 (0.0)	135 (8.5)	985 (0.0)	10 (2.9)	51.9 (0.02)	135 (7.6)	547 (0.2)	22 (5.7)	55.0 (0.1)
Lutjanus griseus	2 (0.1)	11.55 (0.0)	0 (0.0)	0 (0.0)	4 (0.2)	4.9 (0.0)	1 (0.4)	1.0 (0.0)	32 (2.0)	258 (0.0)	6 (1.7)	22.6 (0.0)	24 (1.4)	66.0 (0.0)	2 (0.5)	2.0 (0.0)
Rhomboplites aurorubens	25 (1.7)	176 (0.0)	2 (1.3)	11.8 (0.0)	41 (1.8)	187 (0.1)	2 (0.7)	19.0 (0.0)	413 (26.0)	5197 (0.3)	112 (32.5)	1234 (0.3)	236 (13.4)	1772 (0.5)	58 (15.0)	308 (0.5)
Lobotes surinamensis	1 (0.1)	6.4 (0.0)	0 (0.0)	0 (0.0)	20 (0.9)	24.0 (0.0)	2 (0.7)	2.0 (0.0)	4 (0.2)	15.6 (0.0)	0 (0.0)	0 (0.0)	81 (4.6)	124 (0.0)	21 (5.4)	37.0 (0.1)
Haemulidae	6 (0.4)	65.7 (0.0)	0 (0.0)	0 (0.0)	6 (0.3)	13.0 (0.0)	2 (0.7)	2.0 (0.0)	55 (3.5)	1420 (0.1)	7 (2.0)	514 (0.1)	19 (1.1)	60.2 (0.0)	1 (0.3)	1.0 (0.0)
Cynoscion spp.	9 (0.6)	126 (0.0)	1 (0.6)	5.7 (0.0)	5 (0.2)	21.0 (0.0)	3 (1.1)	18.0 (0.0)	338 (21.2)	19269 (0.96)	41 (11.9)	1088 (0.3)	230 (13.0)	7820 (2.2)	19 (4.9)	85.0 (0.2)
Sciaenops ocellatus	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	214 (13.4)	7925 (0.4)	32 (9.3)	579 (0.1)	188 (10.6)	3718 (1.0)	16 (4.1)	108 (0.2)

Table 5 (continued).

Taxon	Spring Survey								Fall Survey							
	Bongo				Neuston				Bongo				Neuston			
	GOM		UNIS		GOM		UNIS		GOM		UNIS		GOM		UNIS	
	OCC	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**
Mullidae	162 (11.2)	3584 (0.3)	30 (19.48)	541 (0.3)	1165 (50.9)	52386 (27.0)	211 (75.6)	19534 (47.4)	12 (0.8)	39.7 (0.0)	1 (0.3)	6.9 (0.0)	106 (6.0)	573 (0.2)	26 (6.7)	203 (0.4)
Chaetodontidae	25 (1.7)	163 (0.0)	1 (0.6)	7.4 (0.0)	59 (2.6)	107 (0.1)	1 (0.4)	1.0 (0.0)	11 (0.7)	57.8 (0.0)	3 (0.9)	22.4 (0.0)	14 (0.8)	36.1 (0.0)	6 (1.6)	6.0 (0.0)
Pomacanthidae	33 (2.3)	285 (0.0)	1 (0.6)	5.1 (0.0)	28 (1.2)	41.2 (0.0)	3 (1.1)	3.0 (0.0)	13 (0.8)	78.7 (0.0)	1 (0.3)	12.9 (0.0)	16 (0.9)	24.1 (0.0)	1 (0.3)	1.0 (0.0)
Mugilidae	79 (5.4)	1063 (0.1)	13 (8.4)	179 (0.1)	703 (30.7)	10357 (5.3)	131 (47.0)	1614 (3.9)	40 (2.5)	261 (0.0)	2 (0.6)	14.8 (0.0)	236 (13.4)	1426 (0.4)	8 (2.1)	18.0 (0.0)
Pomacentridae	117 (8.0)	1578 (0.1)	3 (2.0)	258 (0.1)	112 (4.9)	346 (0.2)	13 (4.7)	36.0 (0.1)	133 (8.4)	1077 (0.0)	30 (8.7)	189 (0.0)	150 (8.5)	384 (0.1)	17 (4.4)	38.7 (0.1)
Labridae	452 (31.1)	8503 (0.6)	38 (24.7)	633 (0.3)	92 (4.0)	269 (0.1)	12 (4.3)	56.7 (0.1)	648 (40.7)	24302 (1.2)	250 (72.5)	14650 (3.7)	151 (8.6)	539 (0.2)	58 (15.0)	184 (0.3)
Scaridae	408 (28.1)	9339 (0.7)	19 (12.3)	177 (0.1)	92 (4.0)	227 (0.1)	9 (3.2)	12.0 (0.0)	355 (22.3)	7621 (0.4)	71 (20.6)	1420 (0.4)	58 (3.3)	97.9 (0.0)	14 (3.6)	25.9 (0.0)
Acanthuridae	91 (6.3)	1121 (0.1)	2 (1.3)	11.9 (0.0)	38 (1.7)	56.3 (0.0)	1 (0.4)	2.00 (0.0)	26 (1.6)	194 (0.0)	0 (0.0)	0 (0.0)	2 (0.1)	2.0 (0.0)	1 (0.3)	1.0 (0.0)
Trichiurus lepturus	50 (3.4)	963 (0.1)	13 (8.4)	263 (0.1)	24 (1.0)	68.0 (0.0)	3 (1.1)	13.0 (0.0)	231 (14.5)	3110 (0.2)	56 (16.2)	809 (0.2)	49 (2.8)	112 (0.0)	10 (2.6)	25.0 (0.0)
Xiphias gladius	7 (0.5)	45.4 (0.0)	0 (0.0)	0 (0.0)	104 (4.5)	142 (0.1)	3 (1.1)	4.4 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.3)	6.0 (0.0)	0 (0.0)	0 (0.0)
Istiophoridae	43 (3.0)	362 (0.0)	2 (1.30)	32.3 (0.0)	216 (9.4)	585 (0.3)	11 (3.9)	21.9 (0.0)	18 (1.1)	97.8 (0.0)	2 (0.6)	9.6 (0.0)	172 (9.7)	578 (0.2)	23 (5.9)	48.8 (0.1)
Acanthocybium solandri	9 (0.6)	64.0 (0.0)	0 (0.0)	0 (0.0)	4 (0.2)	6.0 (0.0)	0 (0.0)	0 (0.0)	12 (0.8)	70.1 (0.0)	2 (0.6)	12.0 (0.0)	1 (0.1)	2.0 (0.0)	0 (0.0)	0 (0.0)
Scomberomorus cavalla	8 (0.6)	46.3 (0.0)	0 (0.0)	0 (0.0)	20 (0.9)	54.0 (0.0)	0 (0.0)	0 (0.0)	372 (23.4)	3808 (0.2)	44 (12.8)	241 (0.1)	234 (13.2)	1061 (0.3)	43 (11.1)	88.9 (0.2)
Scomberomorus maculatus	14 (1.0)	124.6 (0.0)	5 (3.25)	58.2 (0.0)	22 (1.0)	126 (0.1)	7 (251)	75.0 (0.2)	203 (12.8)	2346 (0.1)	14 (4.1)	91.6 (0.0)	191 (10.8)	1792 (0.50)	13 (3.4)	30.0 (0.0)
Katsuwonus pelamis	325 (22.4)	3764 (0.3)	16 (10.39)	144 (0.1)	238 (10.4)	694 (0.4)	18 (6.4)	43.0 (0.1)	82 (5.2)	934 (0.0)	20 (5.8)	194 (0.0)	46 (2.6)	169 (0.0)	9 (2.3)	33.0 (0.1)
Thunnus spp.	320 (22.0)	5258 (0.4)	20 (12.99)	421 (0.2)	503 (22.0)	2508 (1.3)	25 (9.0)	147 (0.4)	298 (18.7)	5361 (0.3)	61 (17.7)	730 (6.2)	384 (21.7)	3521 (1.0)	65 (16.8)	379 (0.7)
Thunnus albacares	5 (0.3)	36.7 (0.0)	1 (0.65)	7.1 (0.0)	5 (0.2)	10 (0.0)	1 (0.4)	1.0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Table 5 (continued).

Taxon	Spring Survey								Fall Survey							
	Bongo				Neuston				Bongo				Neuston			
	GOM		UNIS		GOM		UNIS		GOM		UNIS		GOM		UNIS	
	OCC	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**	**OCC**	**SUM**
Thunnus atlanticus	65 (4.5)	660 (0.0)	0 (0.0)	0 (0.0)	82 (3.6)	325 (0.2)	1 (0.4)	6.0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Thunnus thynnus	158 (10.9)	2854 (0.2)	7 (4.6)	89.3 (0.0)	239 (10.4)	1381 (0.7)	19 (6.8)	123 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Peprilus alepidotus	4 (0.3)	26.3 (0.0)	1 (0.6)	9.6 (0.0)	2 (0.1)	3.0 (0.0)	0 (0.0)	0 (0.0)	209 (13.1)	2070 (0.1)	35 (10.1)	417 (0.1)	76 (4.3)	282 (0.1)	15 (3.9)	44.3 (0.1)
Peprilus burti	26 (1.8)	233 (0.0)	2 (1.3)	26.4 (0.0)	25 (1.1)	46.1 (0.0)	6 (2.2)	16.0 (0.0)	181 (11.4)	4470 (0.2)	90 (26.1)	3055 (0.8)	28 (1.6)	114 (0.0)	17 (4.4)	77.0 (0.1)

LIST OF FIGURES

NOTE: *The 4-panel display format for comparing spring versus fall, and bongo versus neuston collections, as established for Figure 4 and 6, is adhered to for each taxon treated in Figures 7-70, keyed as follows: A. Spring survey bongo net collections; B. Spring survey neuston net collections; C. Fall survey bongo net collections; D. Fall survey neuston net collections.*

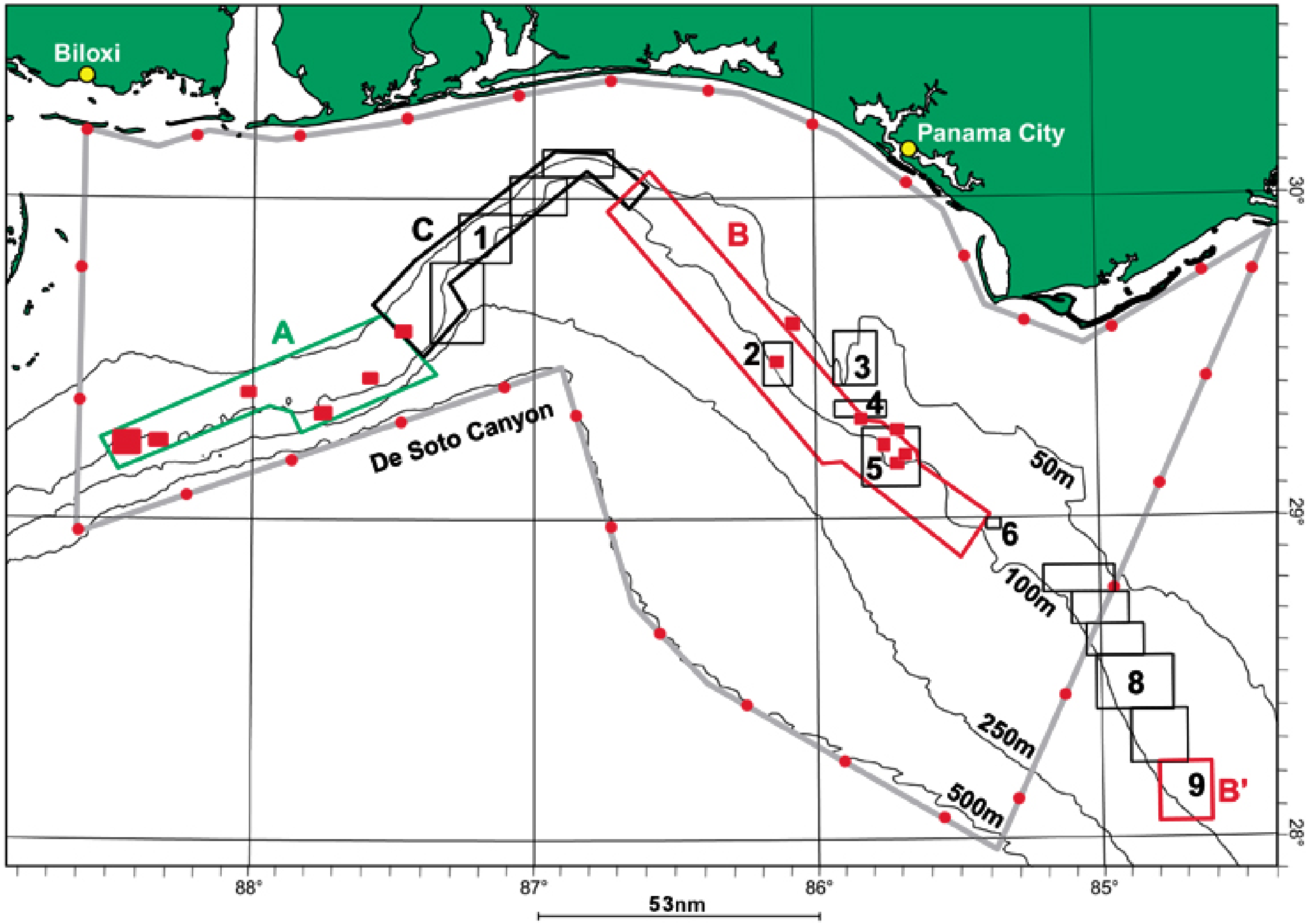


Figure 1. Original MMS IOS-NEGOM Study Area (outer gray polygon). Three smaller polygons, A (green outline), B+B′ (red outline), C (black outline), enclose three areas mapped by USGS in 2000-2002, respectively, using high-resolution multibeam methods (Gardner et al. 2000, 2001b, 2002a, 2002b, 2003). Small numbered individual or grouped outline boxes are NMFS hard-bottom fishery resource interest areas: 1) 29 Edge/27 Edge, 2) Woodward-Clyde Pinnacles, 3) "3-to-5s", 4) Mud Bank, 5) Madison & Swanson Reserve (incl. Whoopie Ground), 6) Twin Ridges, 7) Edges, 8) Steamboat Lumps Reserve. Numbered short black transect lines are Ludwick and Walton (1957) hard-bottom echo-sounder survey transects. Solid red boxes denote USGS deep reef community structure study sites.

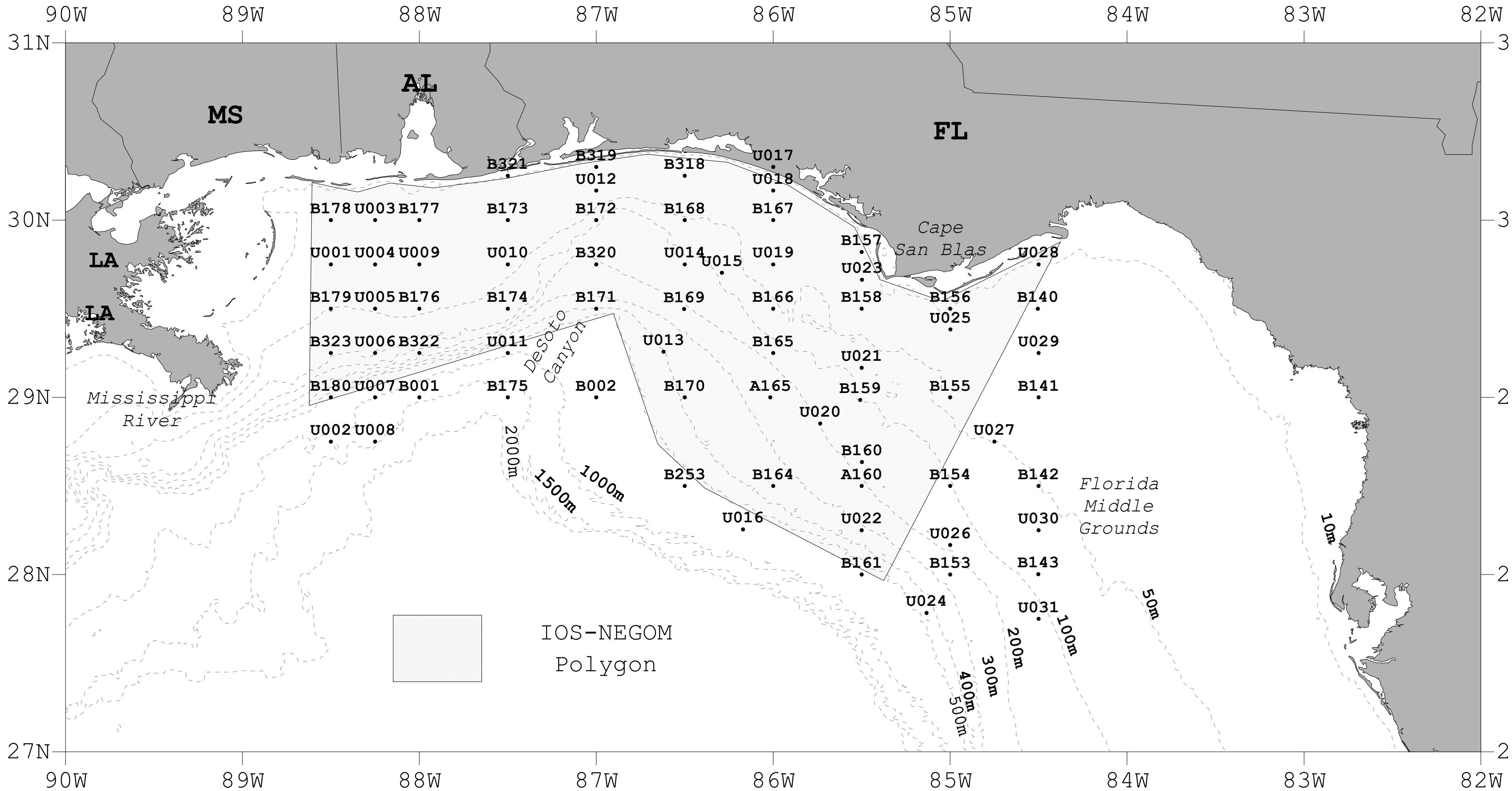


Figure 2. Location of the 72 unique localities or sites (numbered dots) comprising the UNIS Study Area, including the smaller MMS defined IOS-NEGOM polygon (shaded). Ichthyoplankton samples for analysis in the present synopsis were collected at the 72 sites during SEAMAP plankton surveys, 1982-1999.

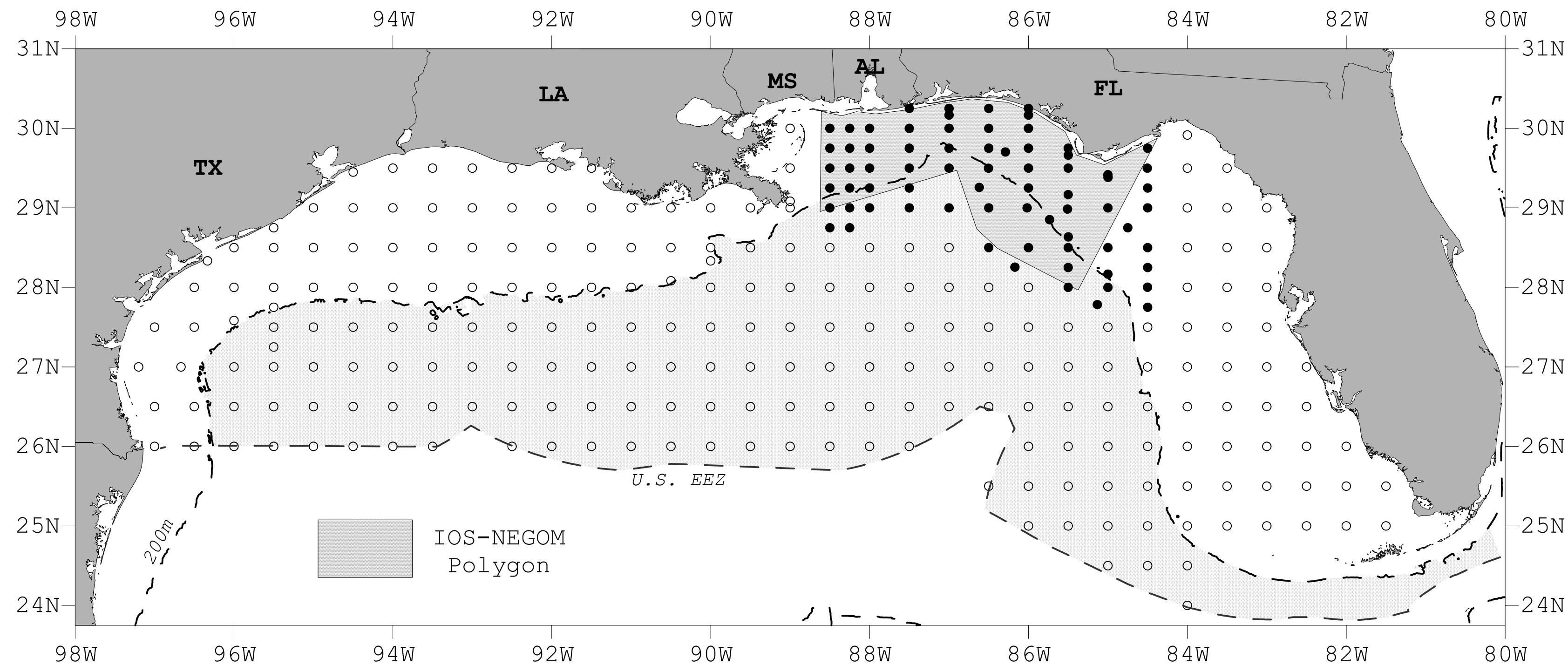


Figure 3. Location of SEAMAP ichthyoplankton stations sampled in the Gulf of Mexico, 1982-1999 surveys (all circles). During fall, survey stations weregenerally located inside the 200 m isobath; during spring, survey stations were located outside the 200 m isobath (lighter shaded area). Survey stations located within the UNIS Study Area (filled circles) extend outside of the MMS IOS-NEGOM polygon (darker shaded area). UNIS stations were sampled during fall and/or spring SEAMAP surveys. U.S. EEZ = United States Exclusive Economic Zone boundary.

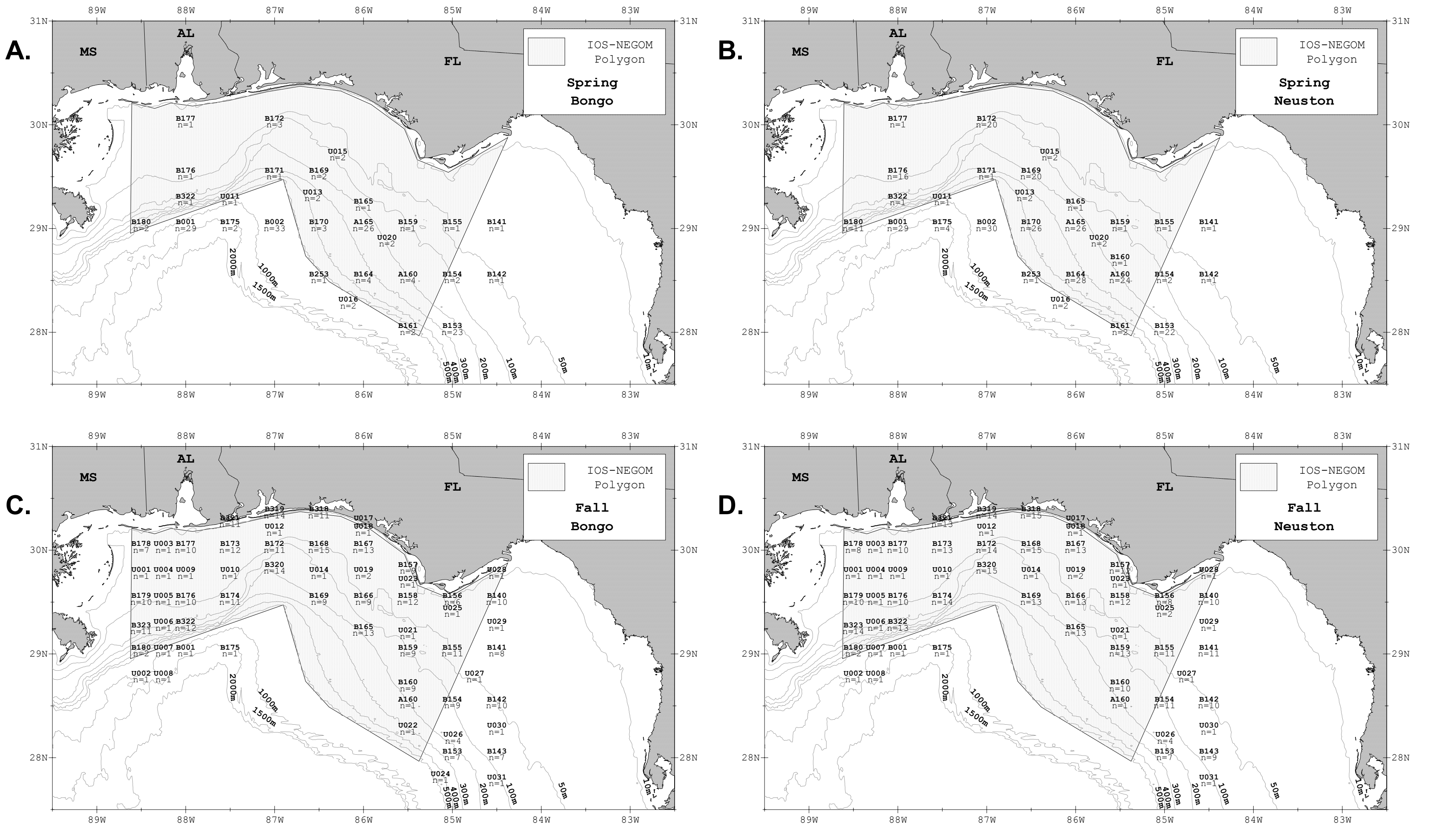


Figure 4. Map showing UNIS Study Area sampling localities and number of samples (n) by survey time frame and gear during SEAMAP plankton surveys, 1982-1999. Key: A. Spring survey bongo net collections; B. Spring survey neuston net collections; C. Fall survey bongo net collections; D. Fall survey neuston net collections.

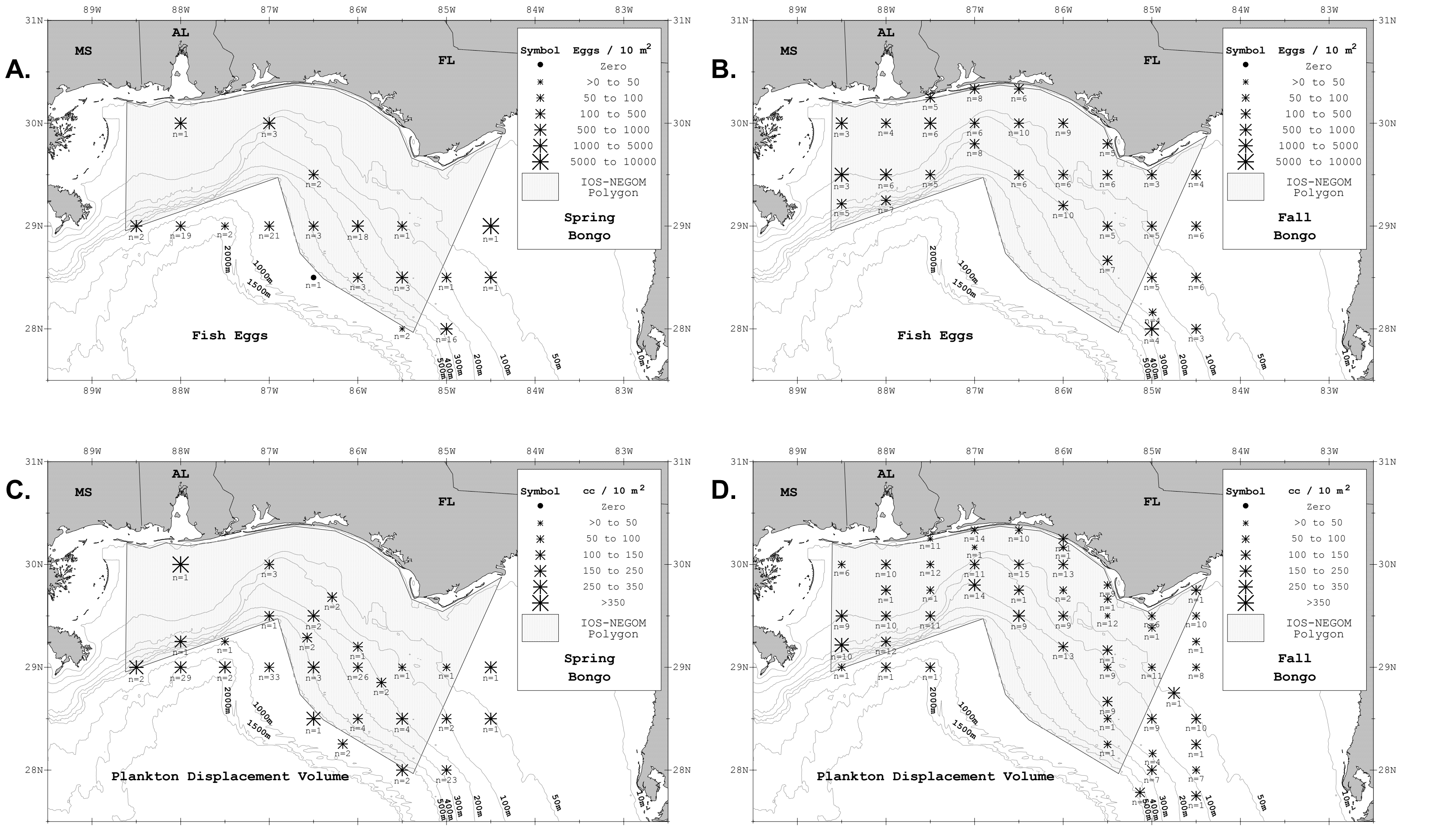


Figure 5. Mean abundance of fish eggs (panels A & B) and mean plankton displacement volume (panels C & D) at UNIS Study Area sampling localities during SEAMAP plankton surveys, 1982-1999. n = number of bongo samples used to calculate mean values. Key: A. Spring survey; B. Fall survey; C. Spring survey; D. Fall survey.

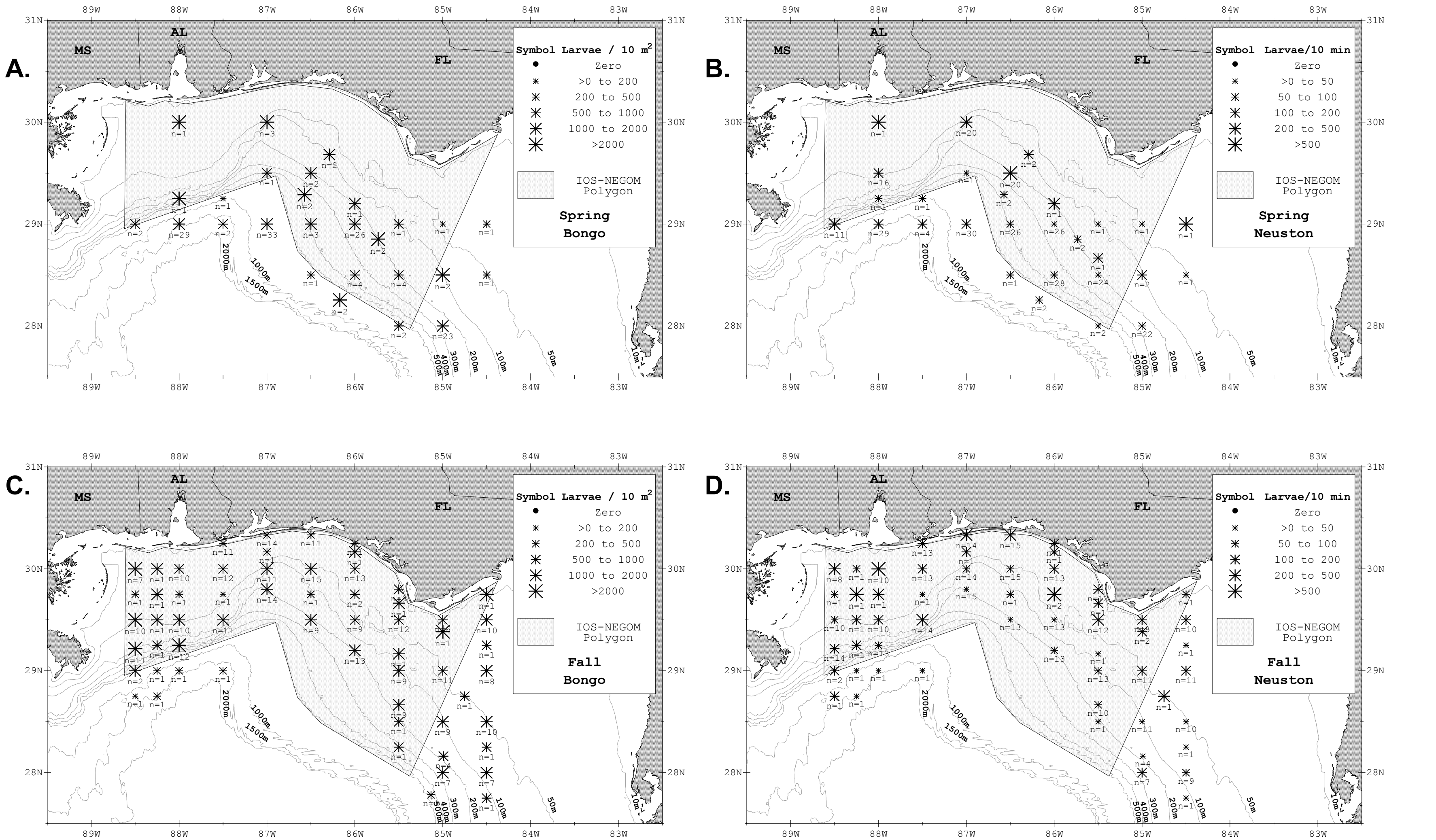


Figure 6. Mean abundance of total fish larvae (all taxa combined) at UNIS Study Area sampling localities during SEAMAP plankton surveys, 1982-1999. n = number of samples used to calculate mean values. Key: A. Spring survey bongo net collections; B. Spring survey neuston net collections; C. Fall survey bongo net collections; D. Fall survey neuston net collections.

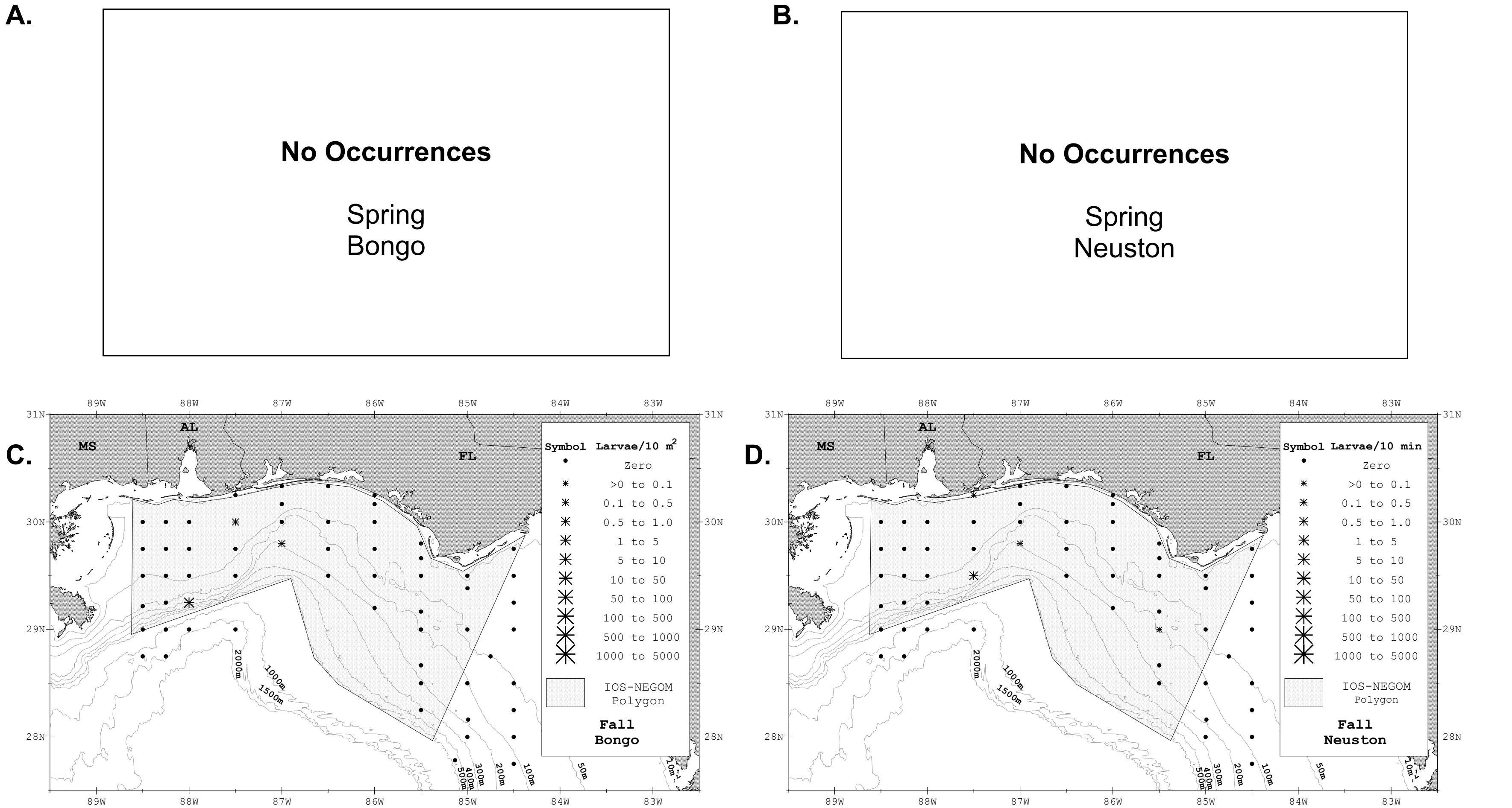


Figure 7. Occurrence and mean abundance of tarpon and/or ladyfish (Elopidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

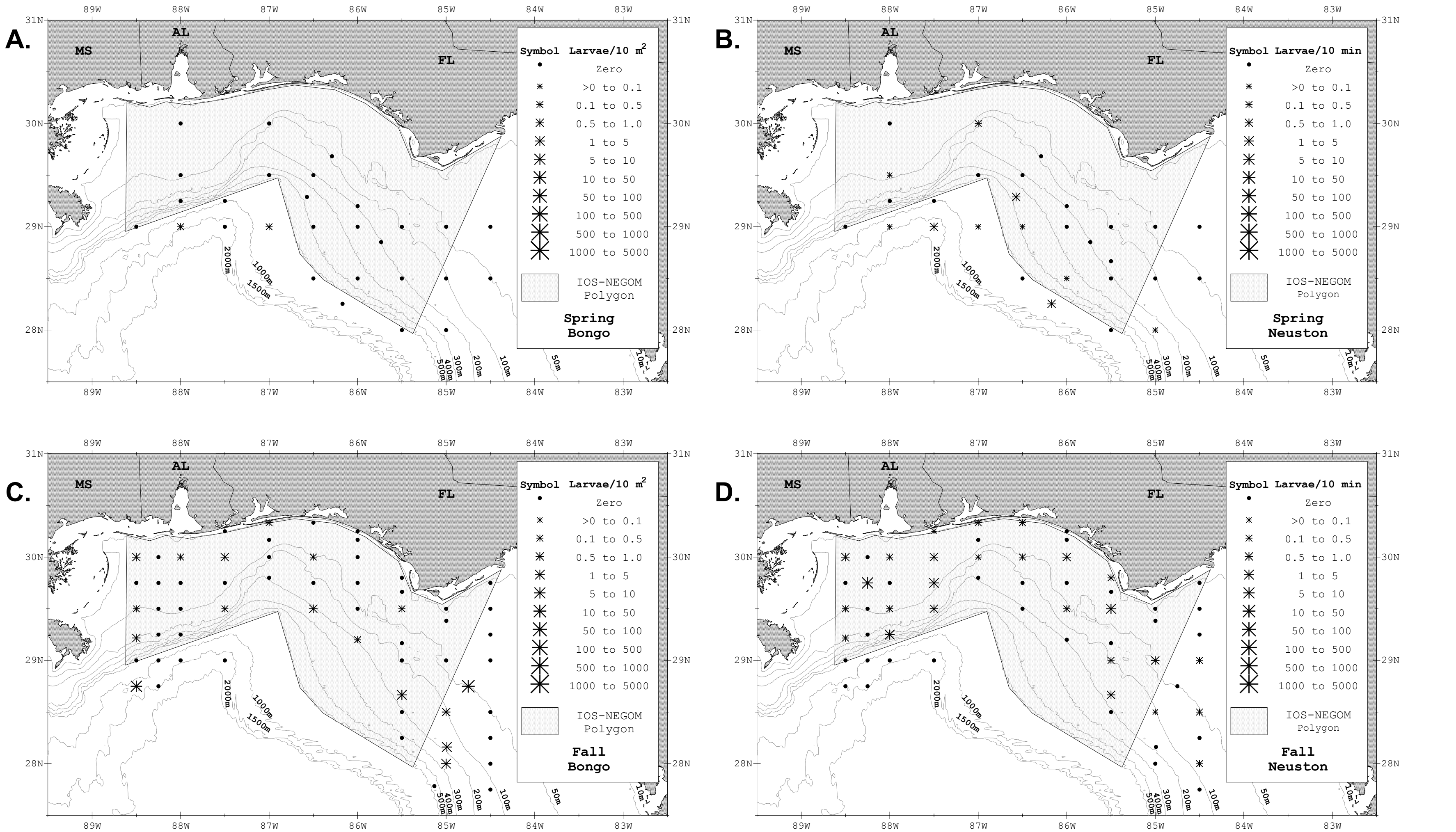


Figure 8. Occurrence and mean abundance of moray eel larvae (Muraenidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

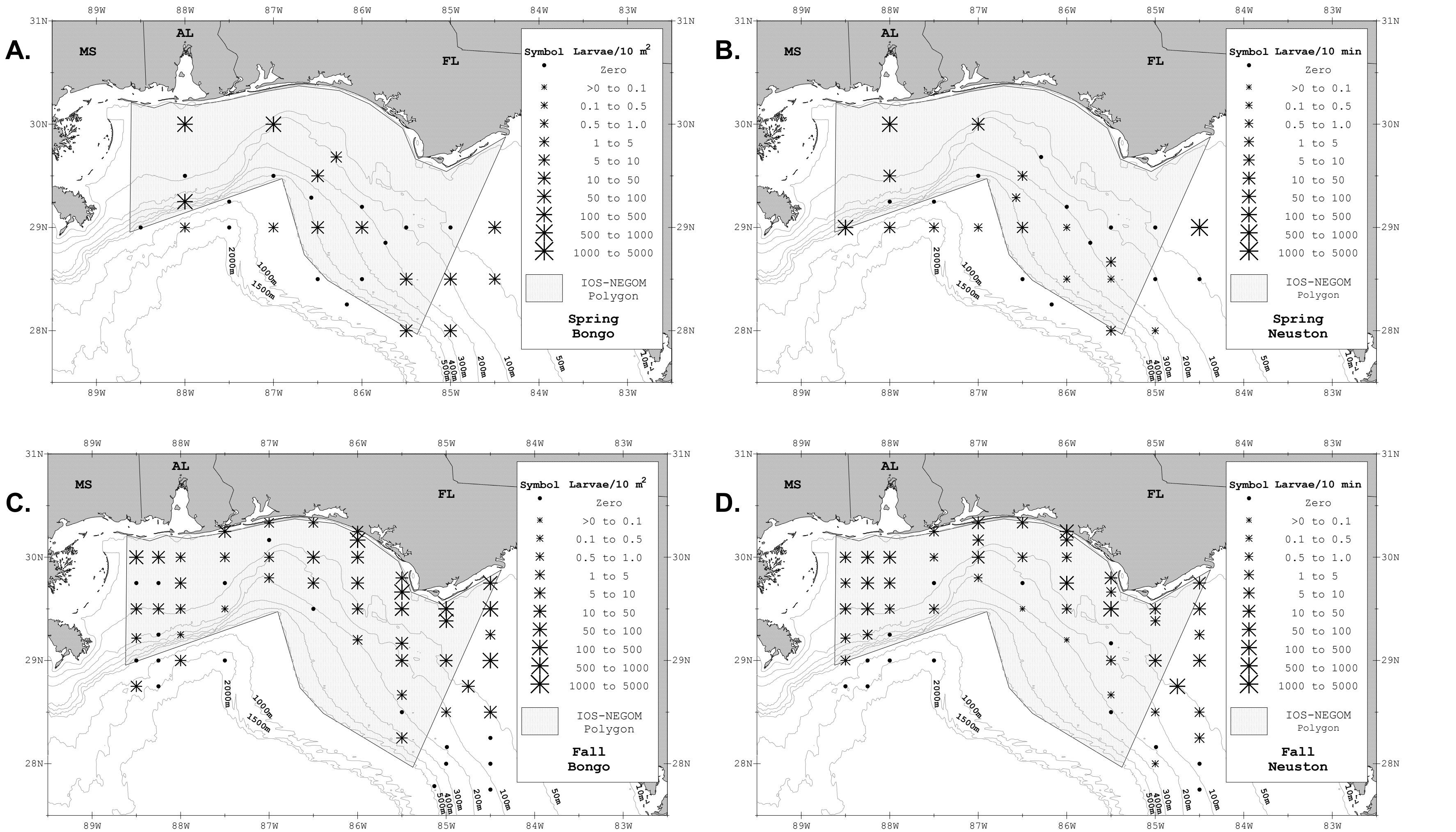


Figure 9. Occurrence and mean abundance of herring (Clupeidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999

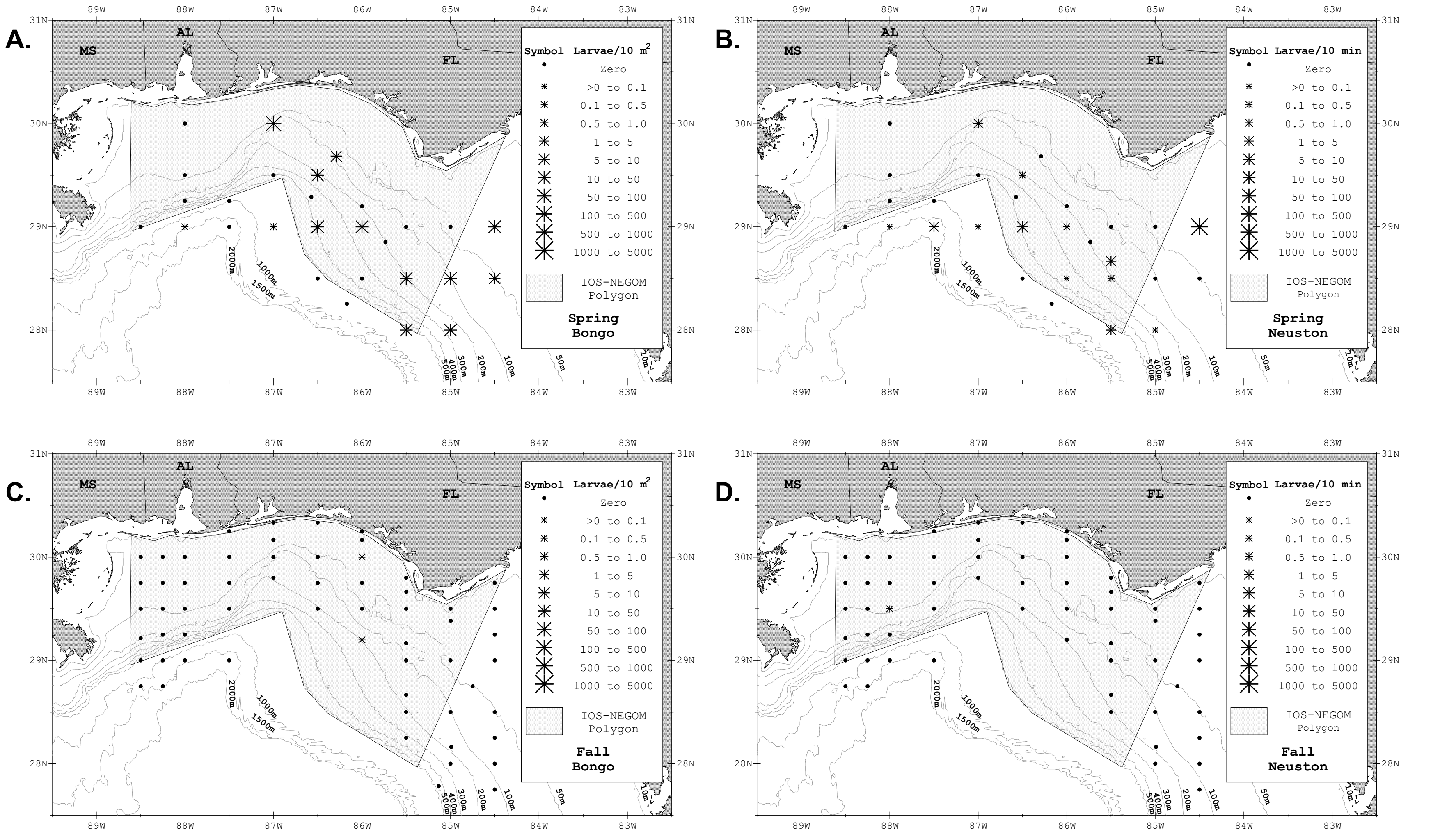


Figure 10. Occurrence and mean abundance of round herring, *Etrumeus teres*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

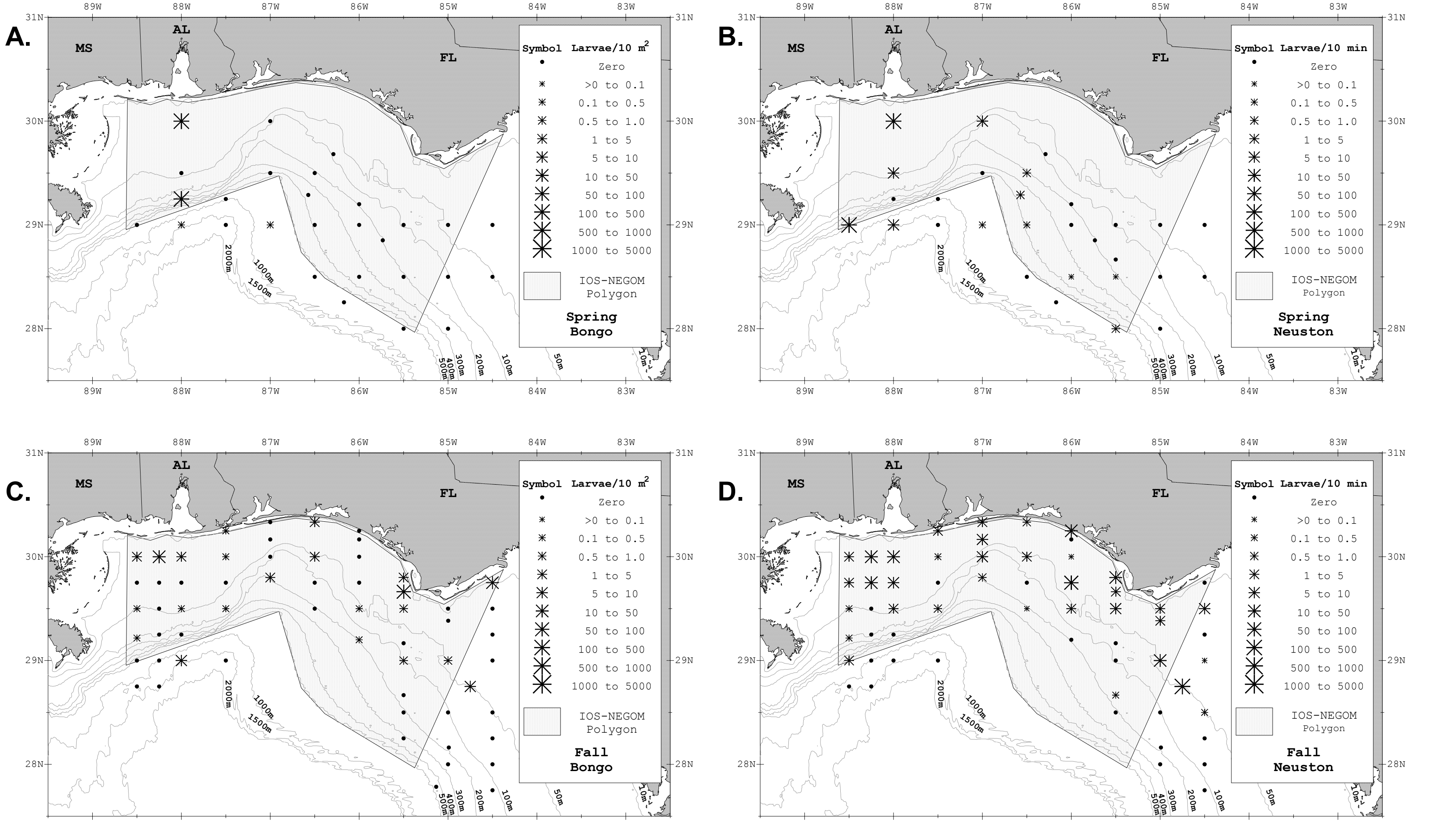


Figure 11. Occurrence and mean abundance of scaled sardine, *Harengula jaguana*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

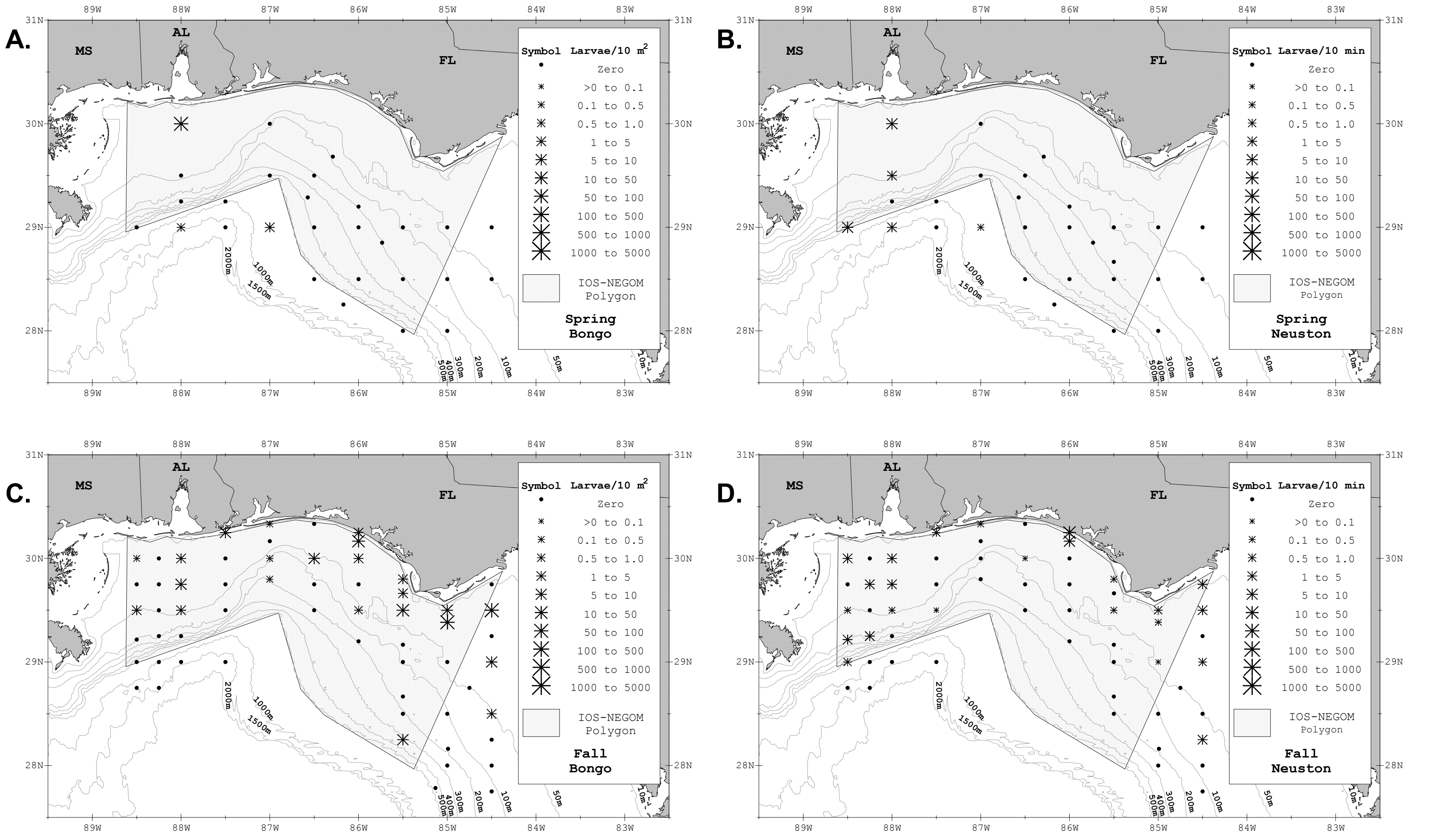


Figure 12. Occurrence and mean abundance of thread herring, *Opisthonema oglinum*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

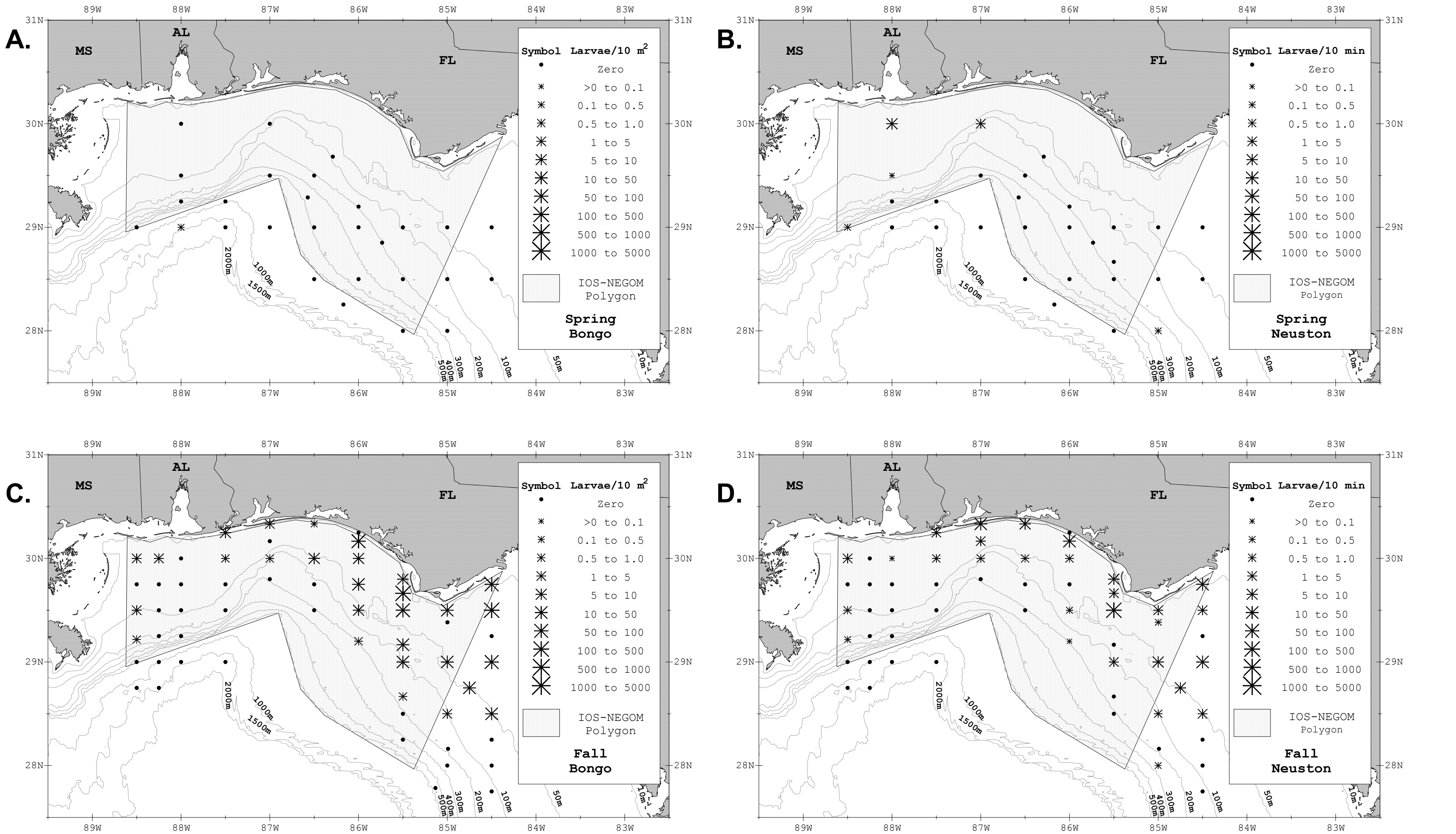


Figure 13. Occurrence and mean abundance of Spanish sardine, *Sardinella aurita*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999. A. Spring survey bongo collections; B. Spring survey neuston collections; C. Fall survey bongo collections; D. Fall survey neuston collections.

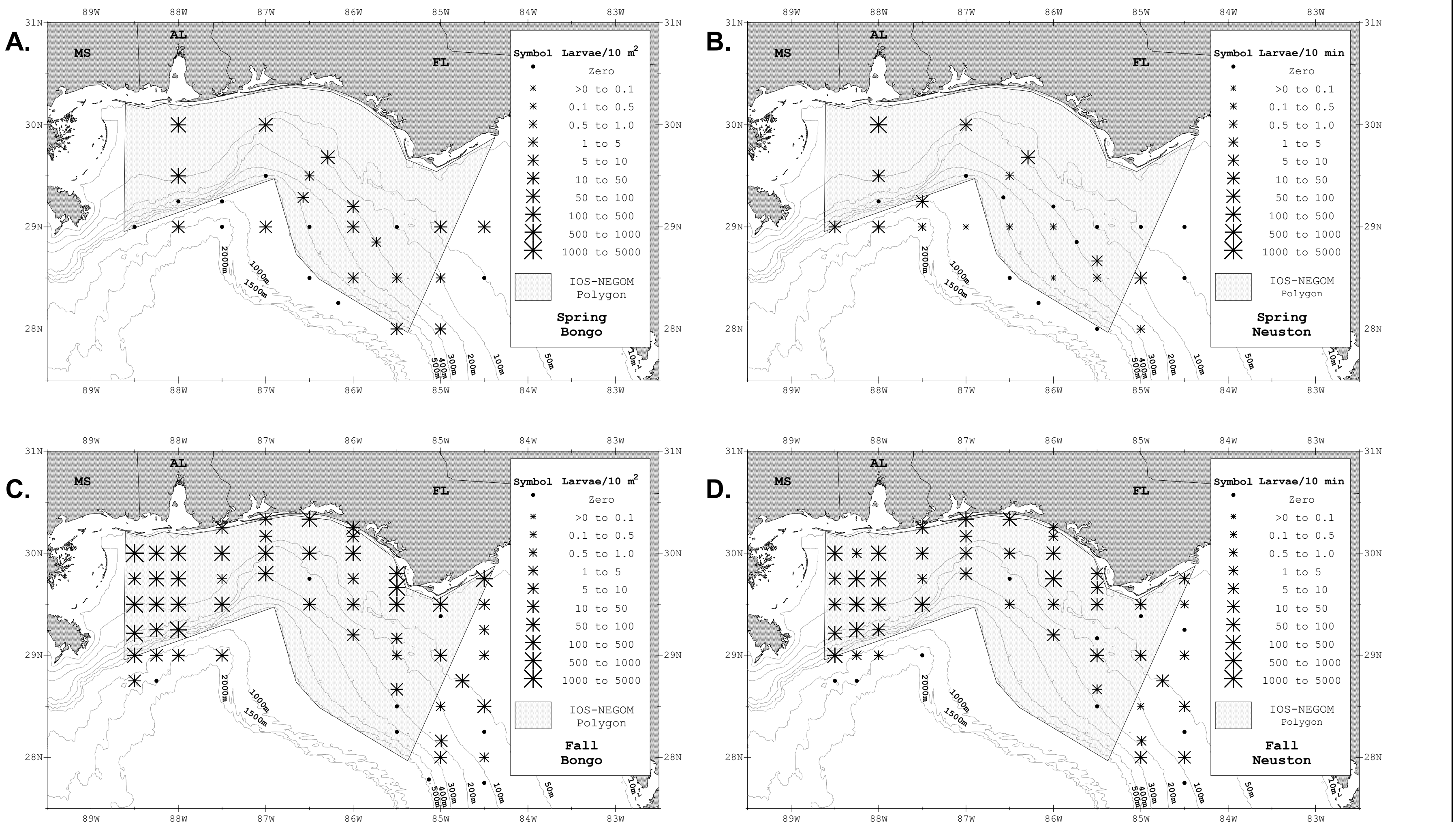


Figure 14. Occurrence and mean abundance of anchovy (Engraulidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

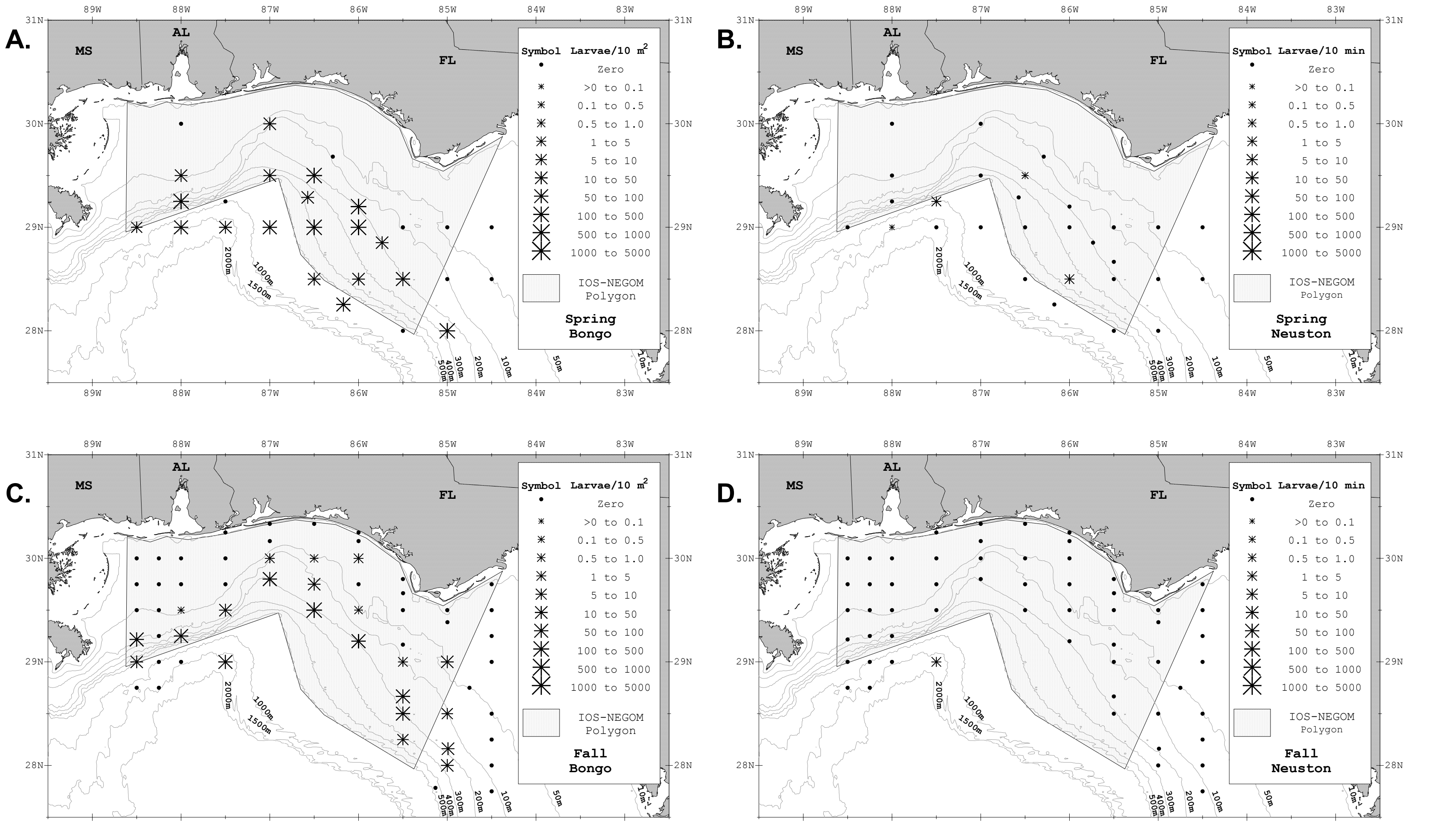


Figure 15. Occurrence and mean abundance of hatchetfish (Sternoptychidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

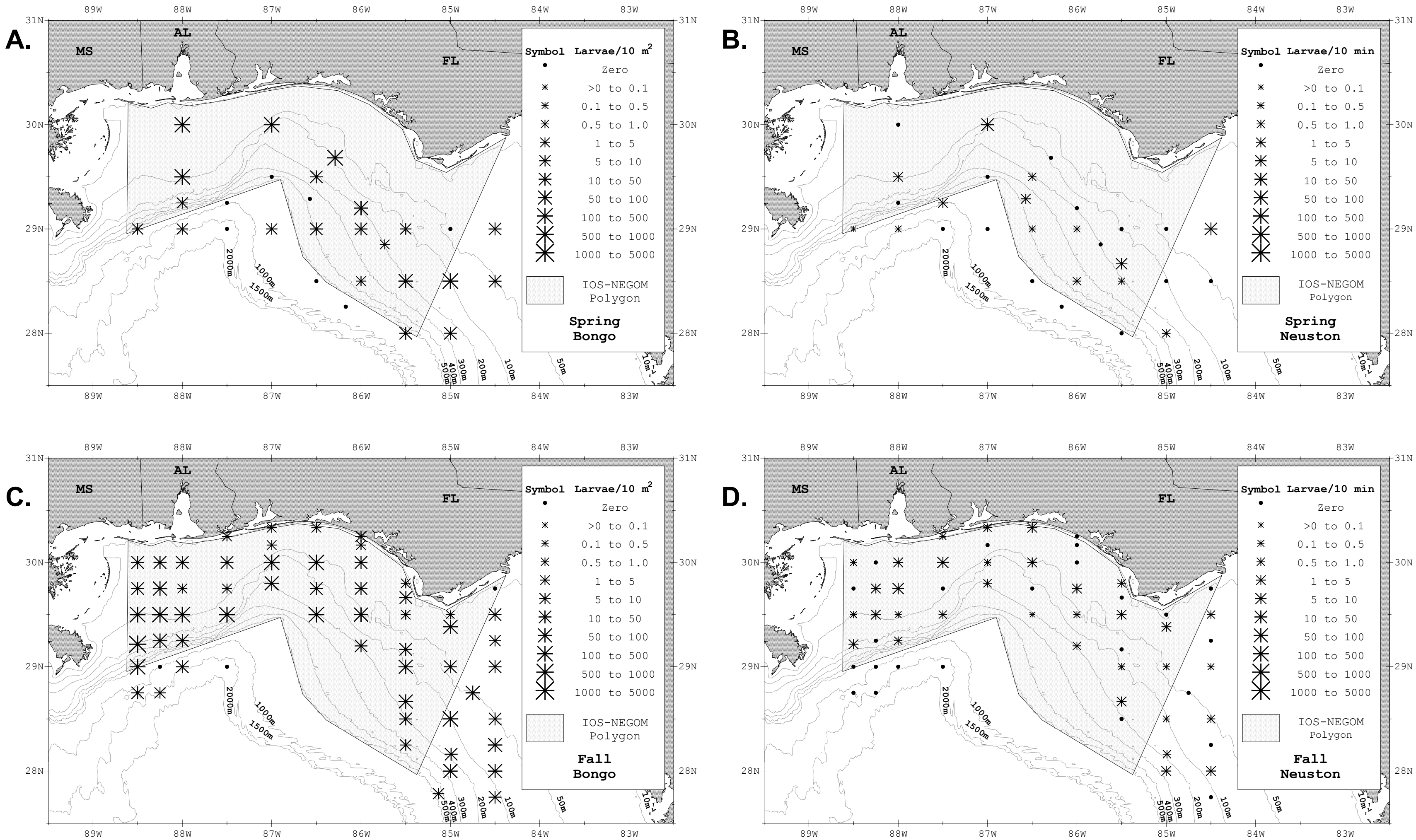


Figure 16. Occurrence and mean abundance of lizardfish (Synodontidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

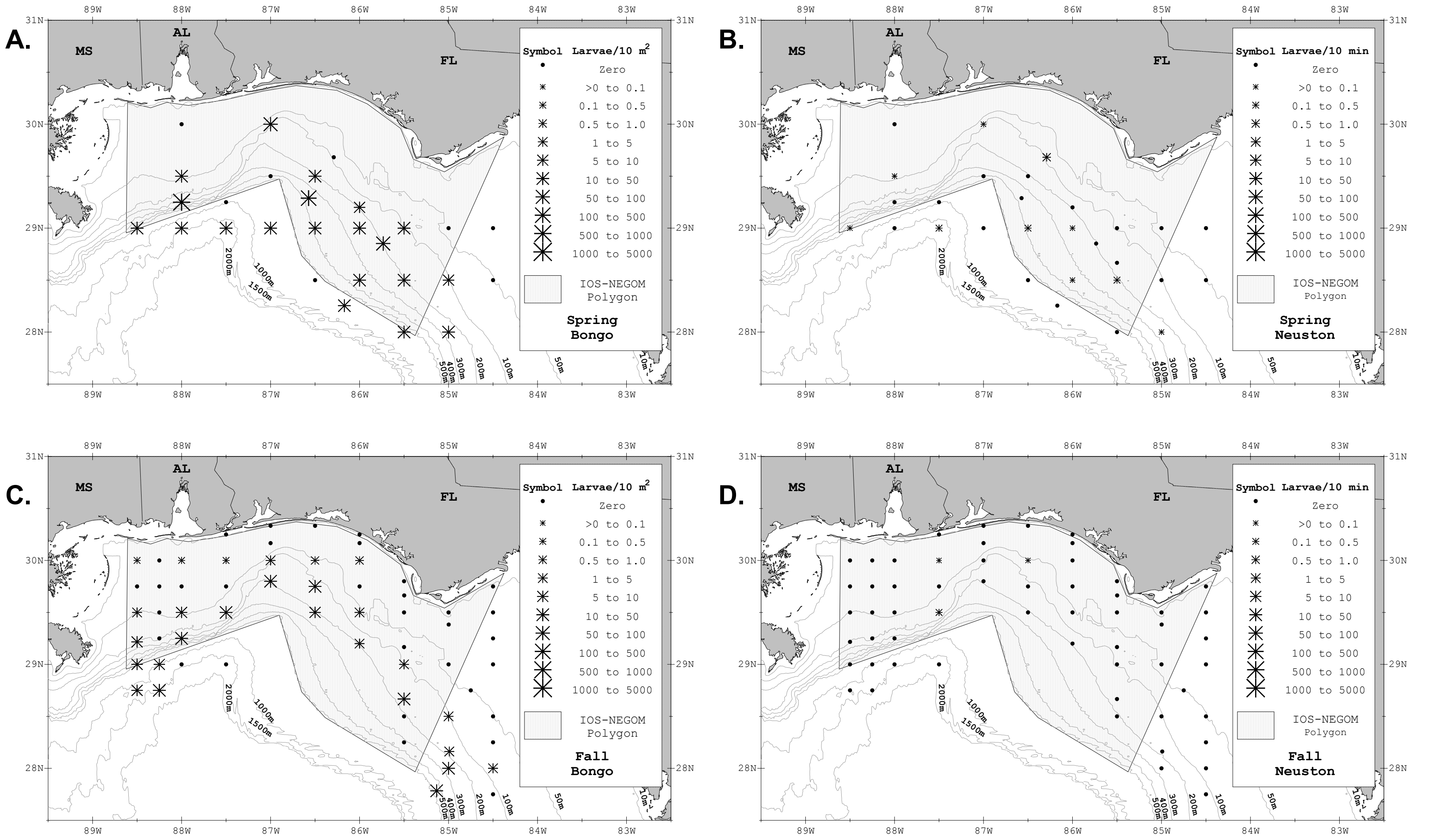


Figure 17. Occurrence and mean abundance of barracudina (Paralepididae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

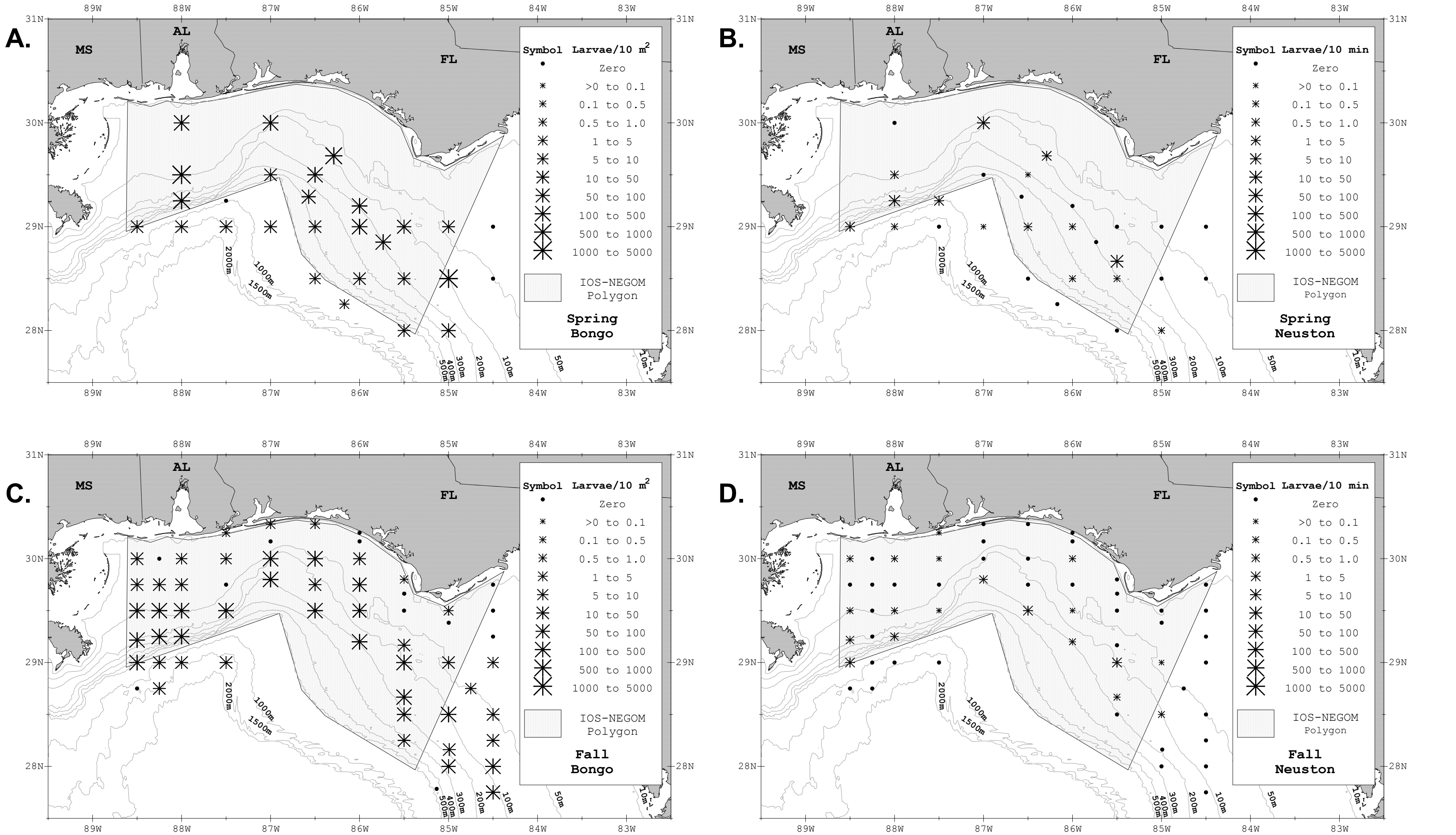


Figure 18. Occurrence and mean abundance of codlet (Bregmacerotidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

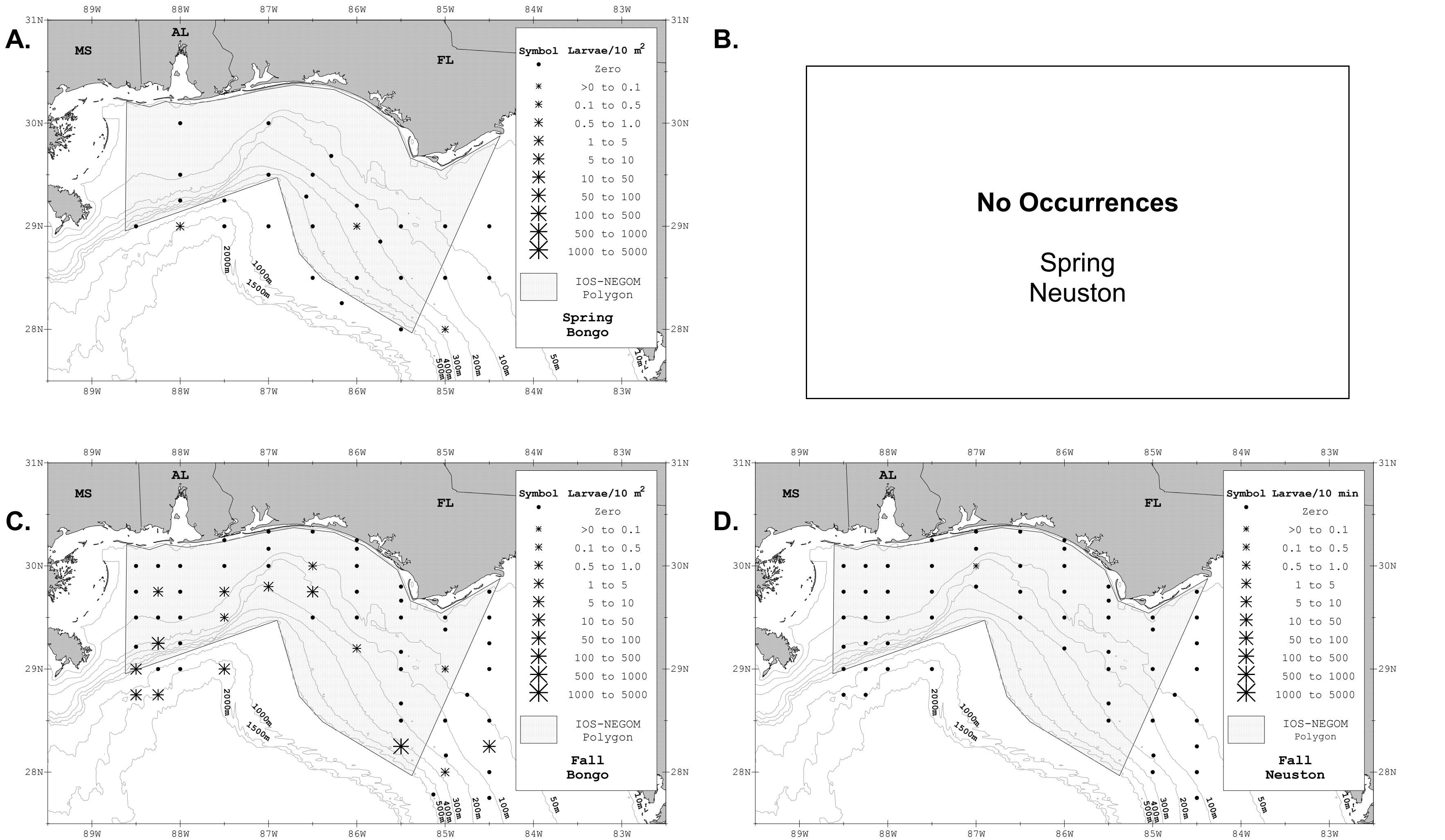


Figure 19. Occurrence and mean abundance of pearlfish (Carapidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

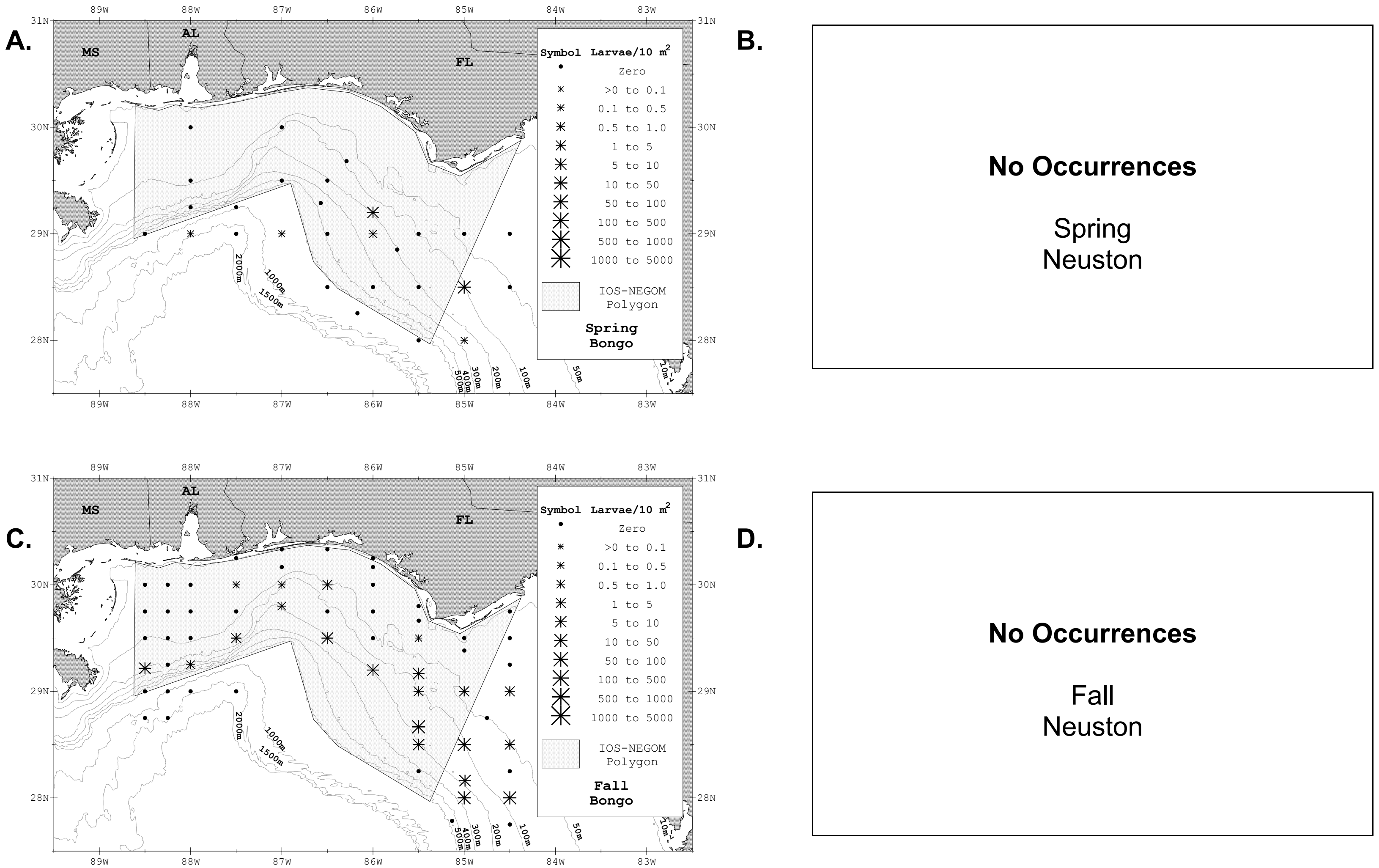


Figure 20. Occurrence and mean abundance of the pearlfish, *Carapus bermudensis*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

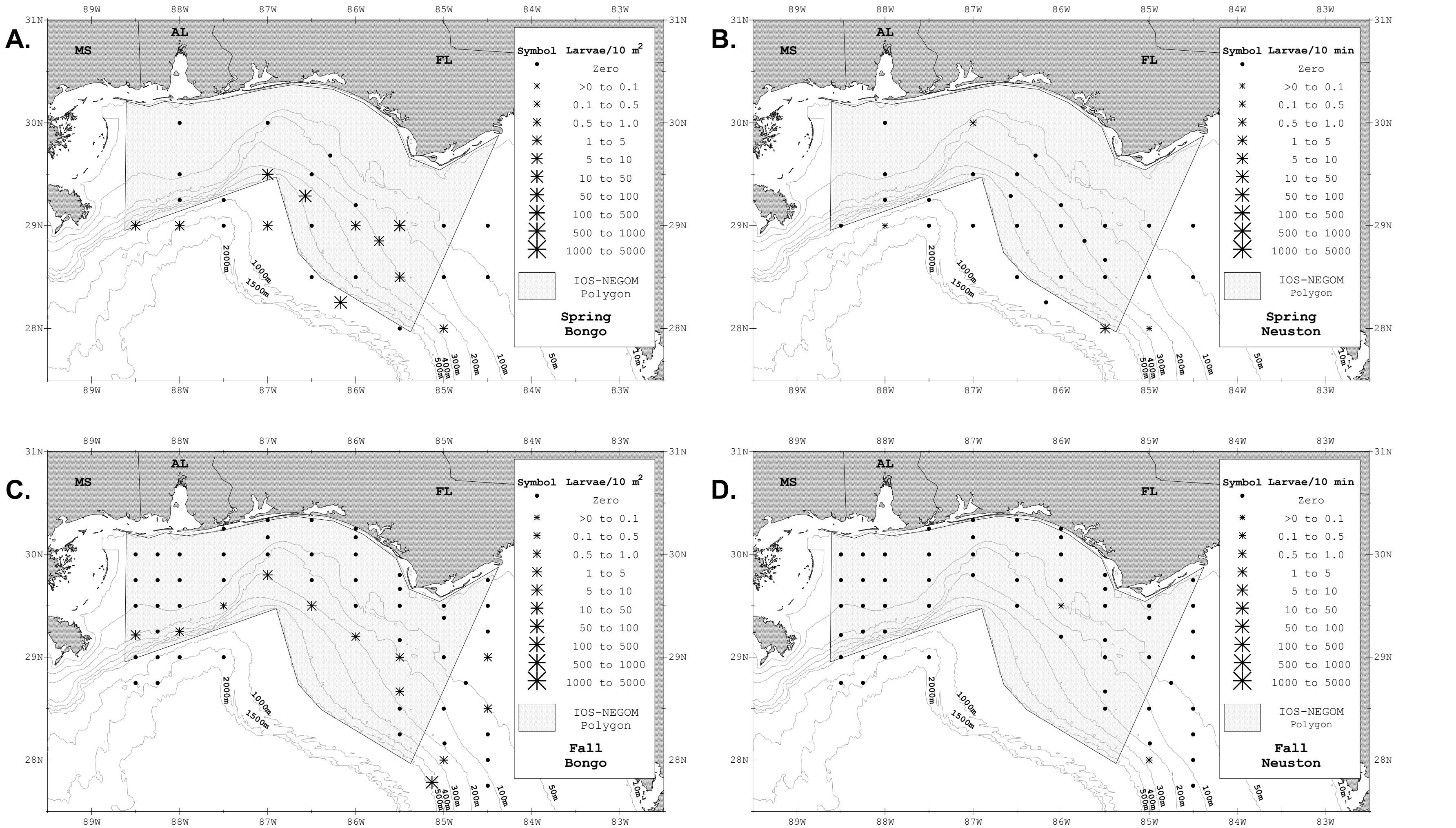


Figure 21. Occurrence and mean abundance of bigscales (Melamphaidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

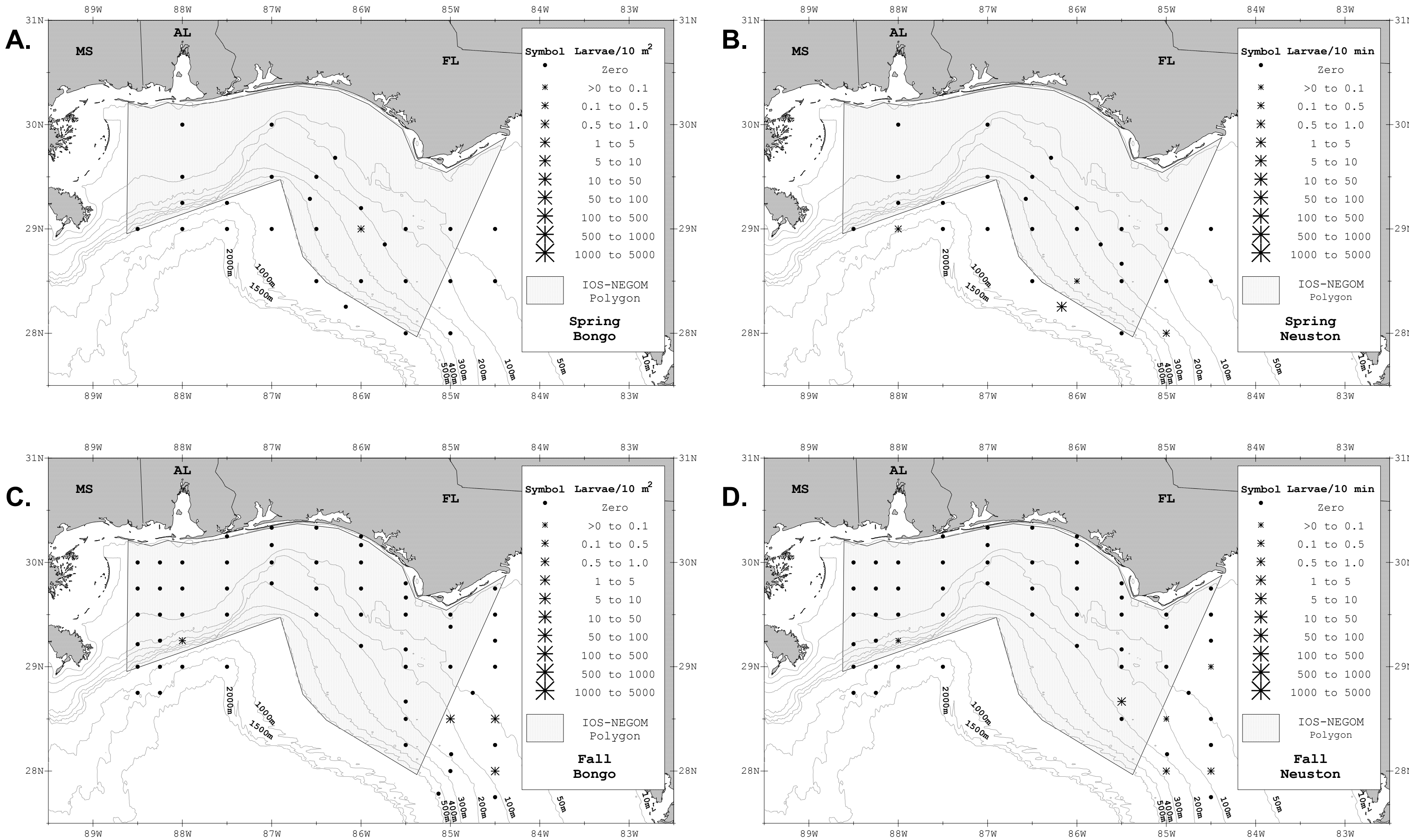


Figure 22. Occurrence and mean abundance of squirrelfish (Holocentridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

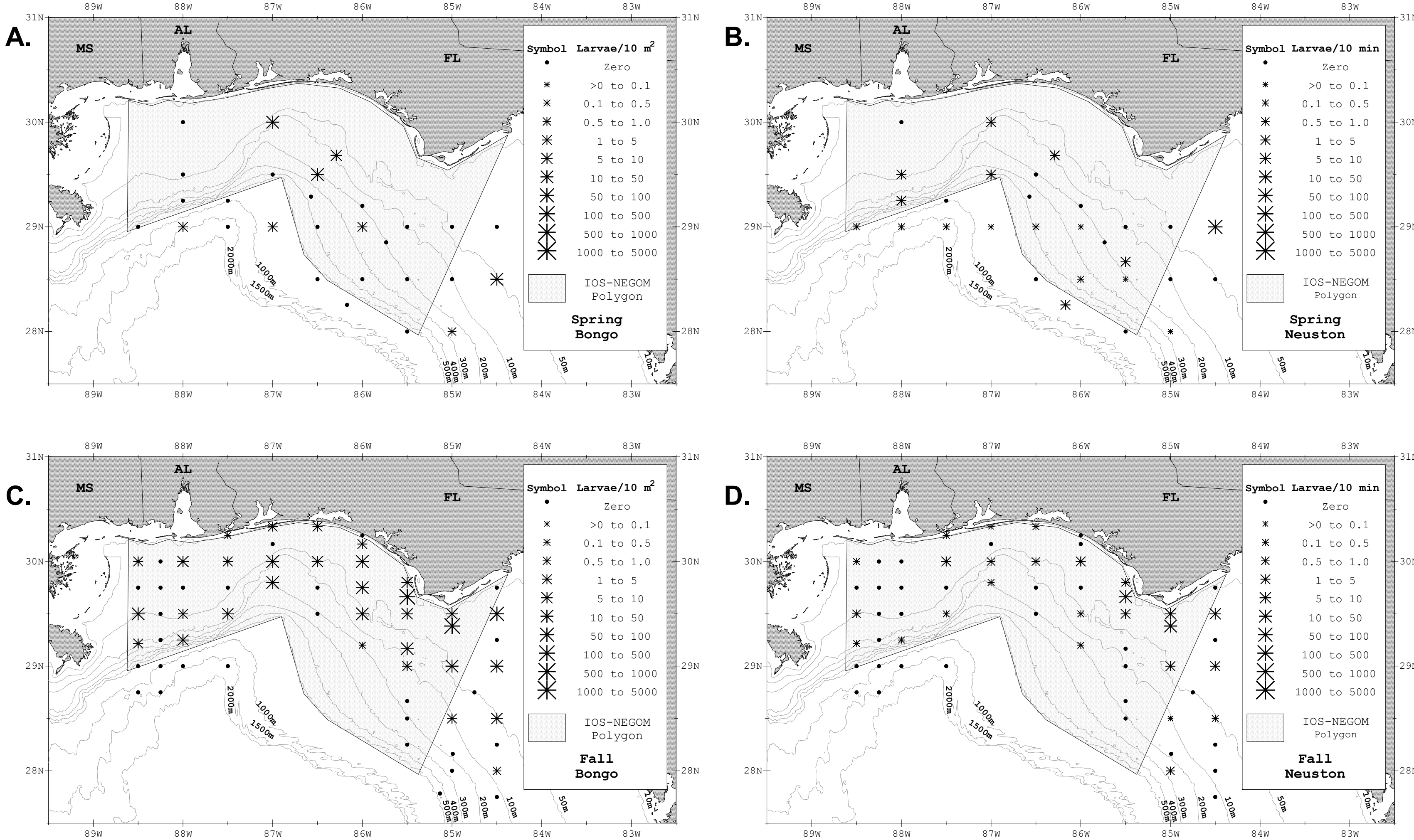


Figure 23. Occurrence and mean abundance of Serraninae larvae (Family Serranidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

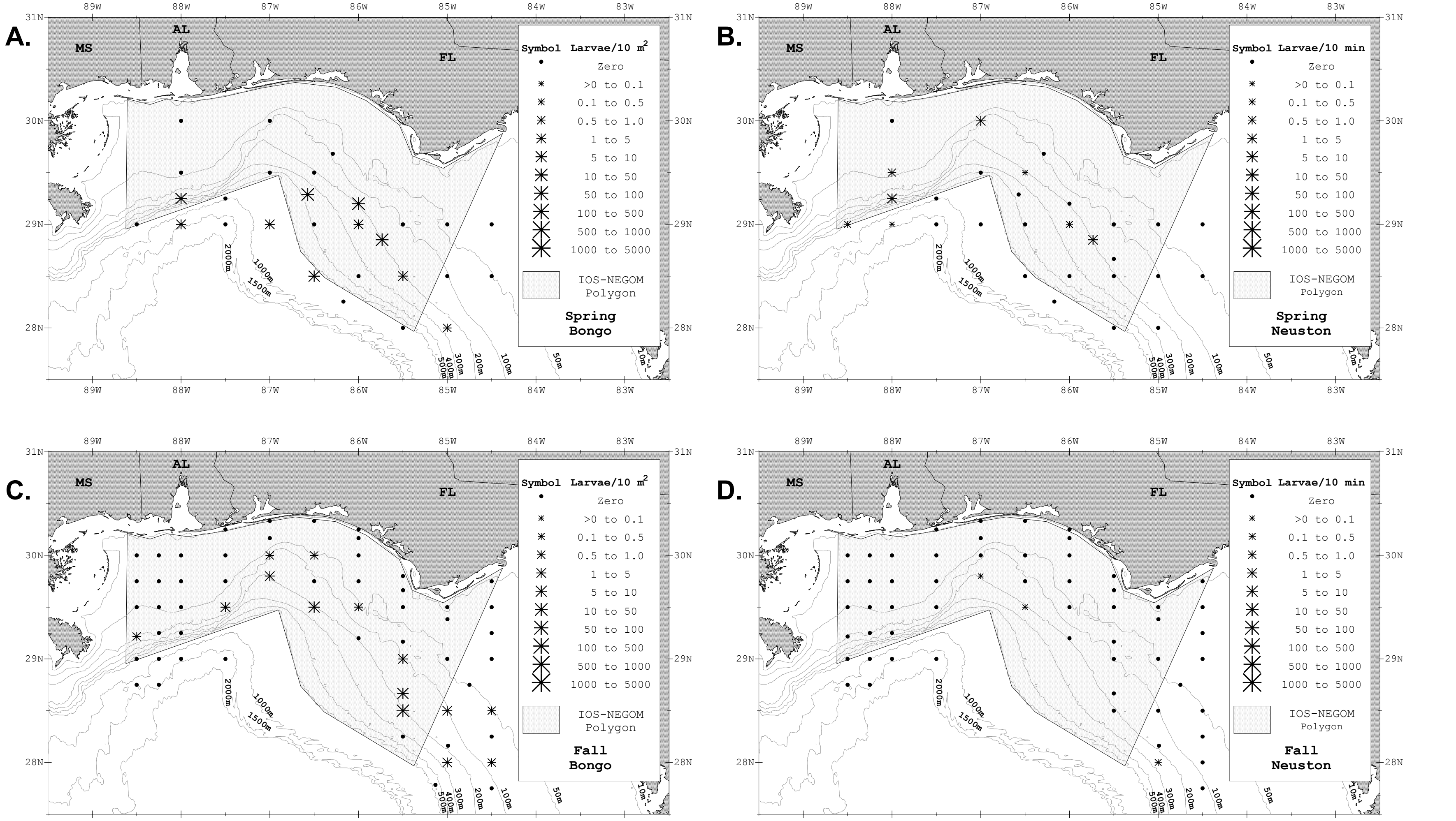
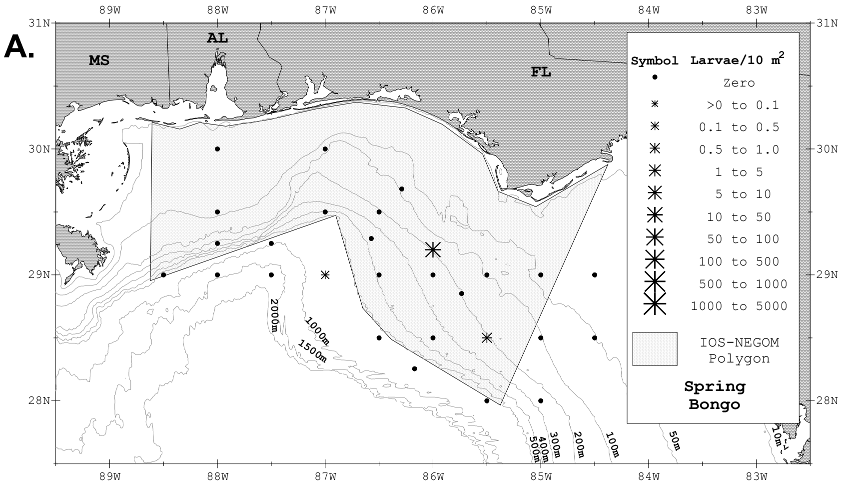


Figure 24. Occurrence and mean abundance of Anthiinae larvae (Family Serranidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.



B.

No Occurrences

Spring
Neuston

C.

No Occurrences

Fall
Bongo

D.

No Occurrences

Fall
Neuston

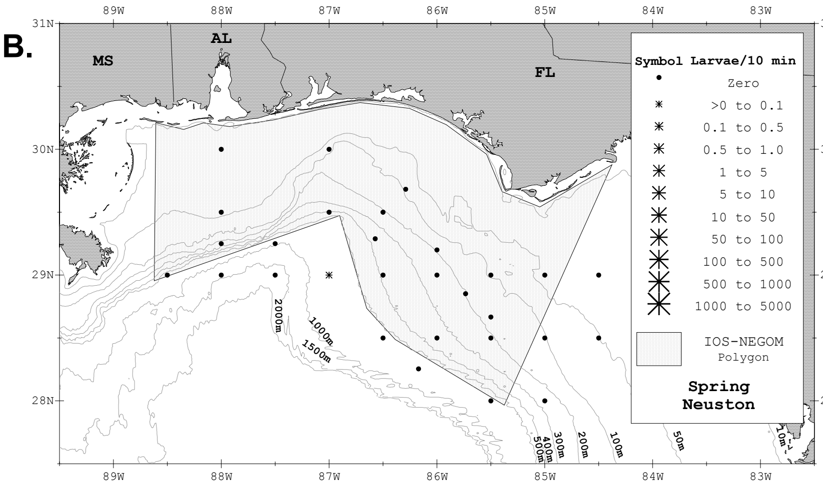
Figure 25. Occurrence and mean abundance of Epinephelinae larvae (Family Serranidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

Spring
Bongo

B.



C.

No Occurrences

Fall
Bongo

D.

No Occurrences

Fall
Neuston

Figure 26. Occurrence and mean abundance of Liopropomatinae larvae (Family Serranidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

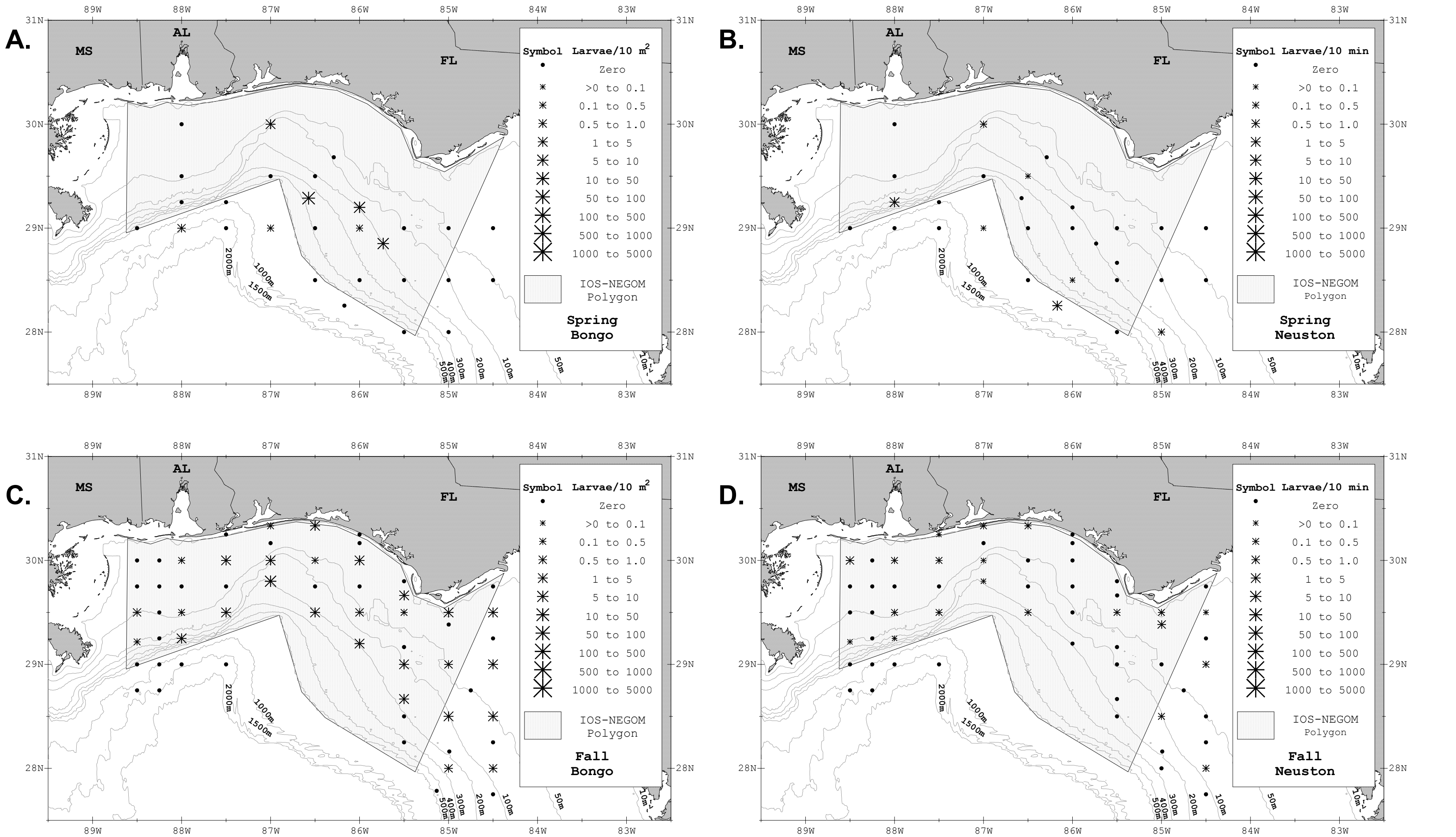


Figure 27. Occurrence and mean abundance of Grammistinae larvae (Family Serranidae) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

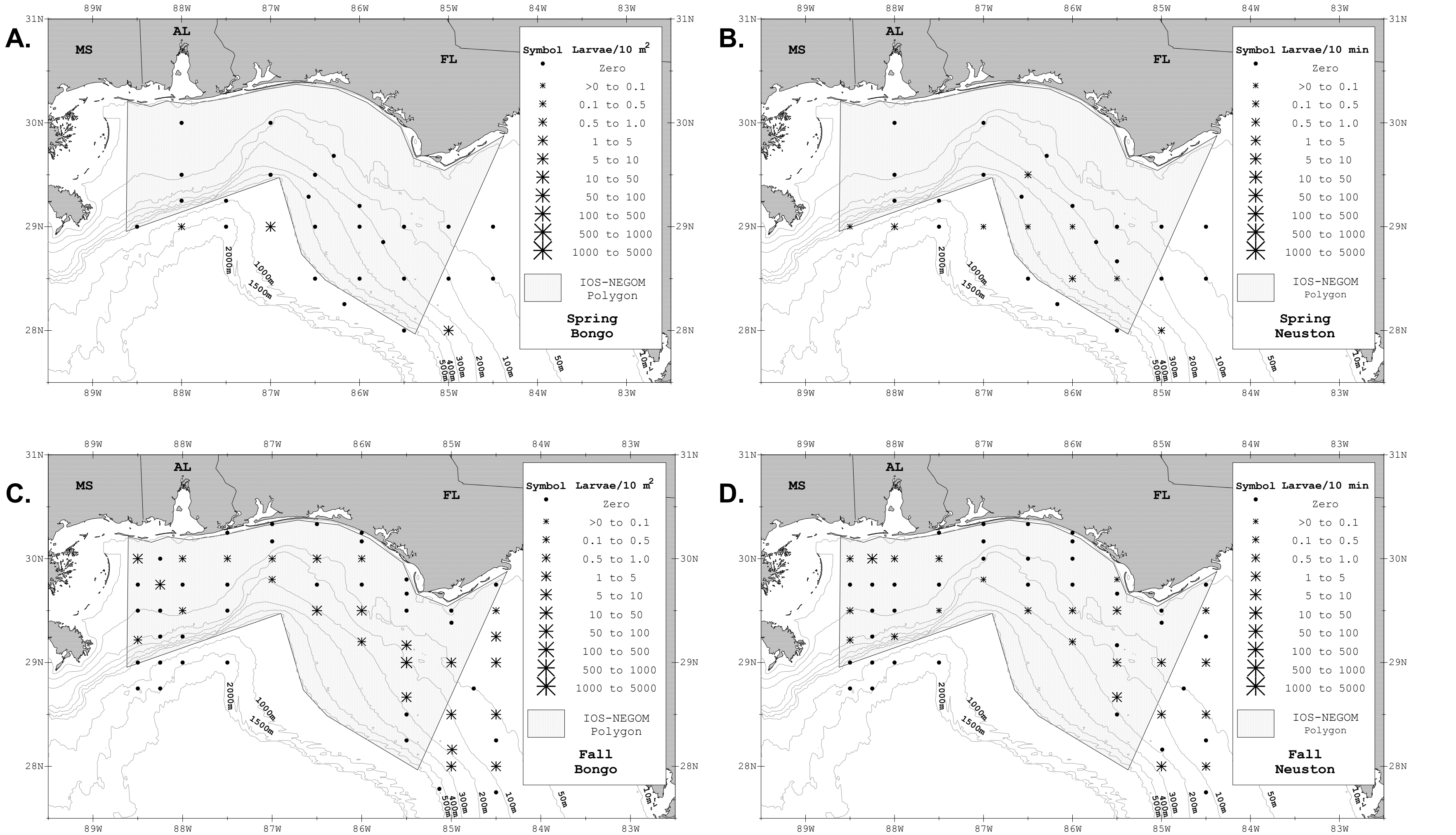


Figure 28. Occurrence and mean abundance of bigeye (Priacanthidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

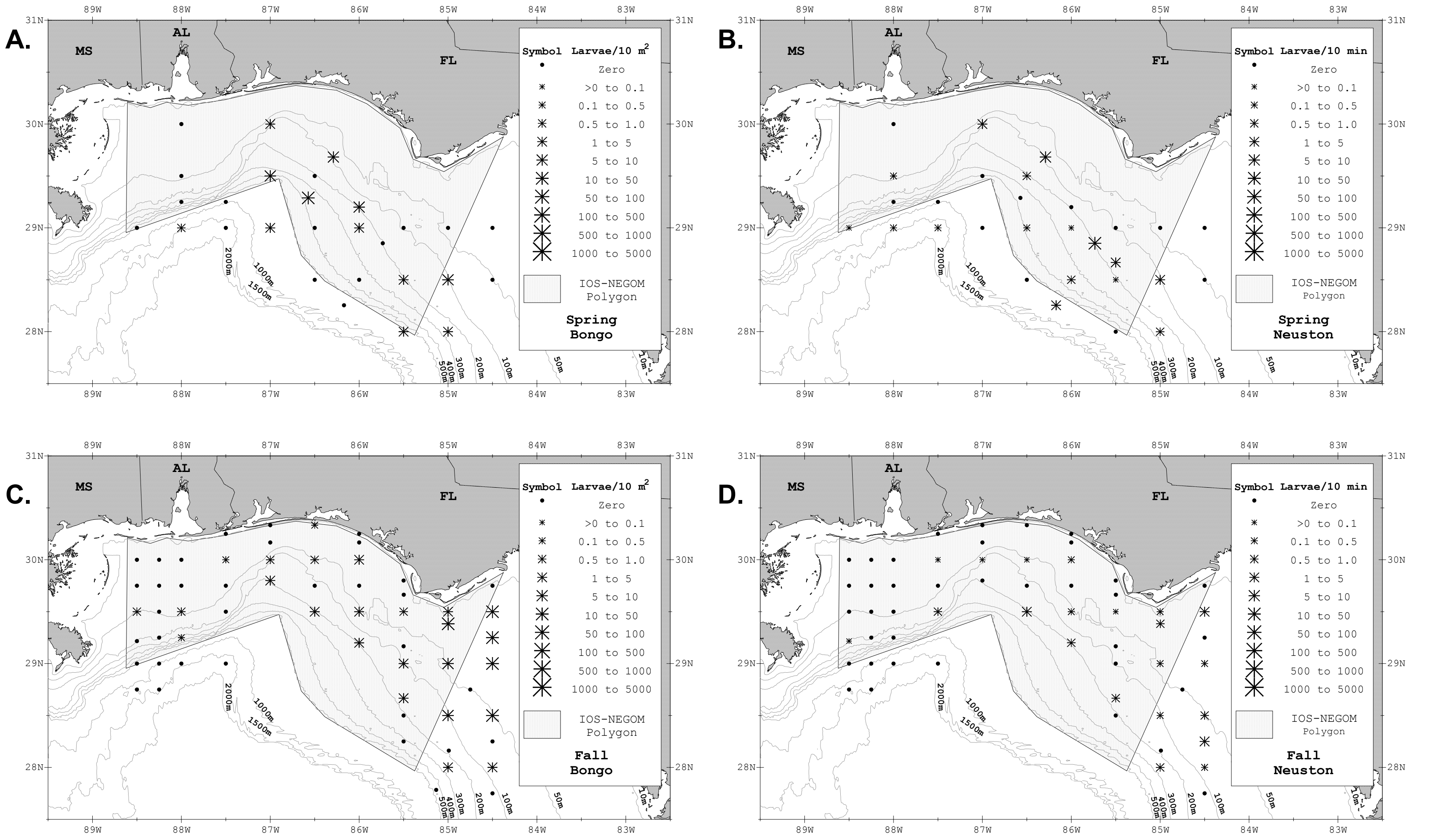


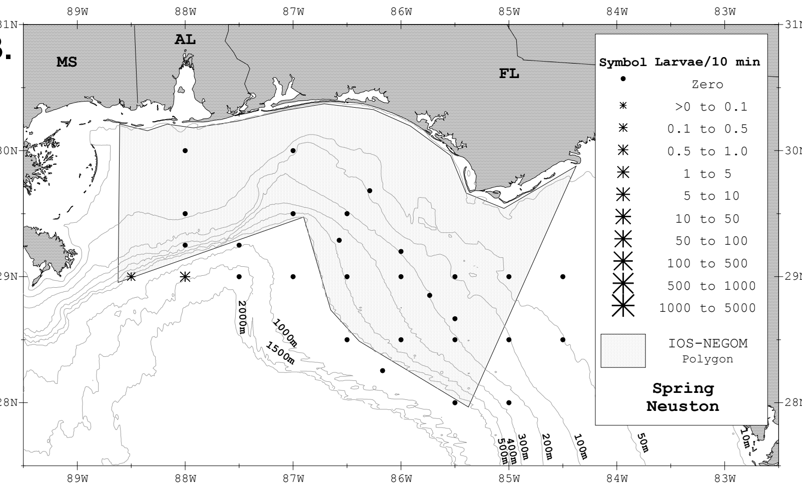
Figure 29. Occurrence and mean abundance of cardinalfish (Apogonidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

Spring
Bongo

B.



C.

No Occurrences

Fall
Bongo

D.

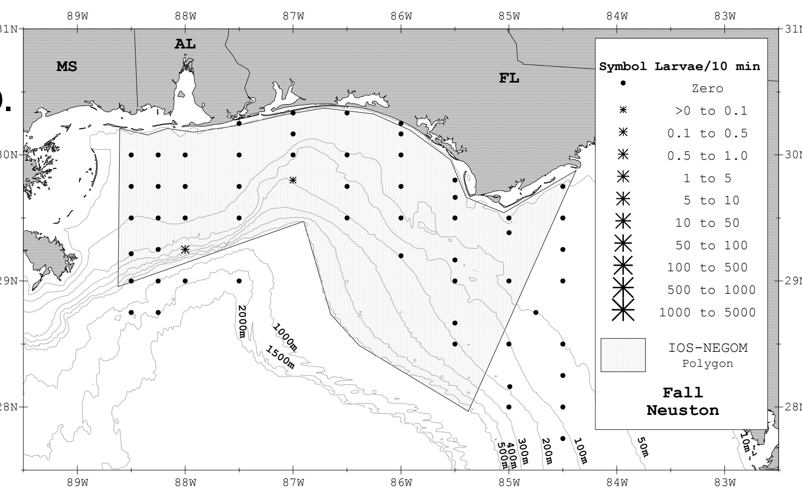


Figure 30. Occurrence and mean abundance of cobia, *Rachycentron canadum*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

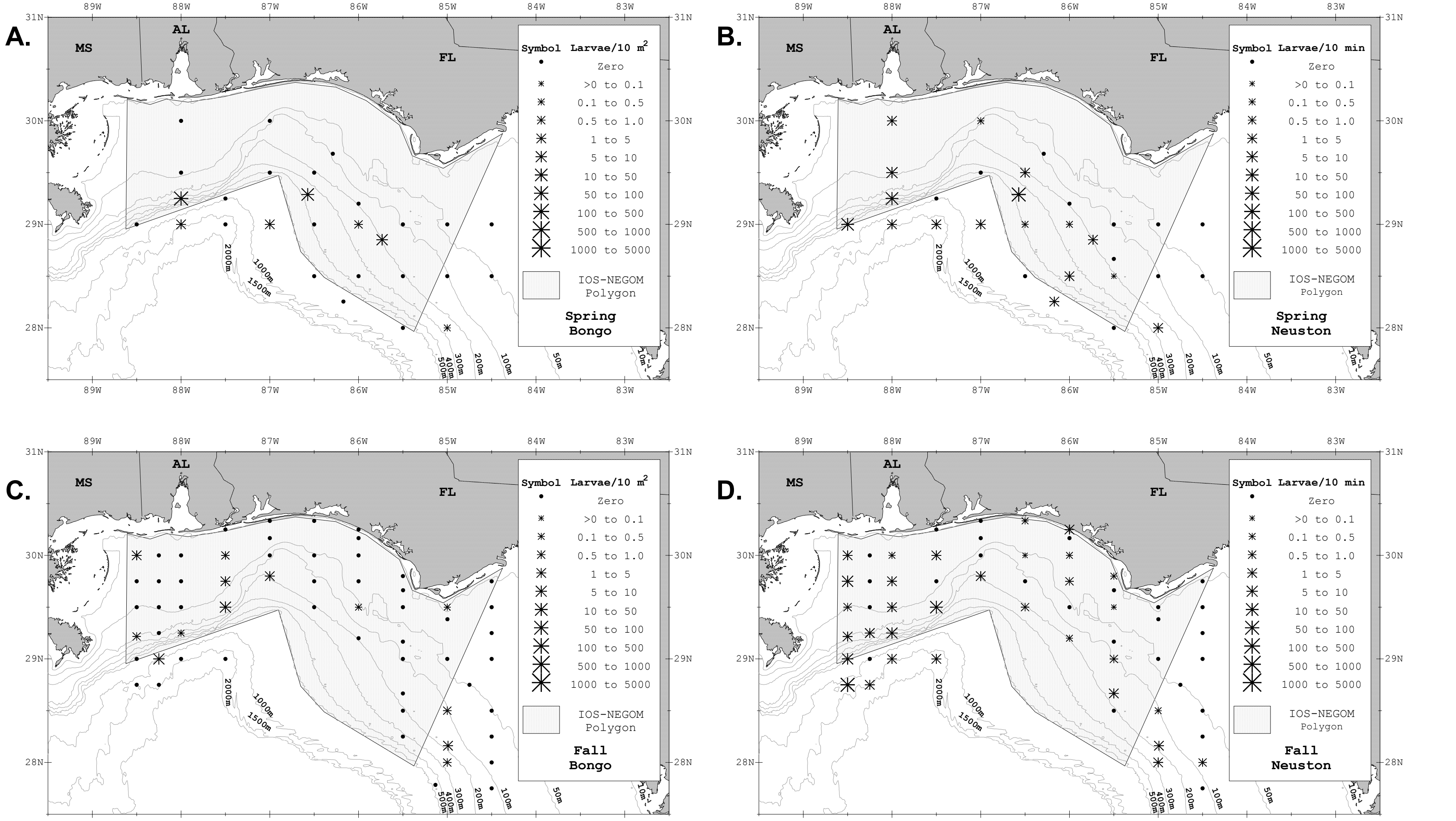


Figure 31. Occurrence and mean abundance of jack larvae, genus *Caranx*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

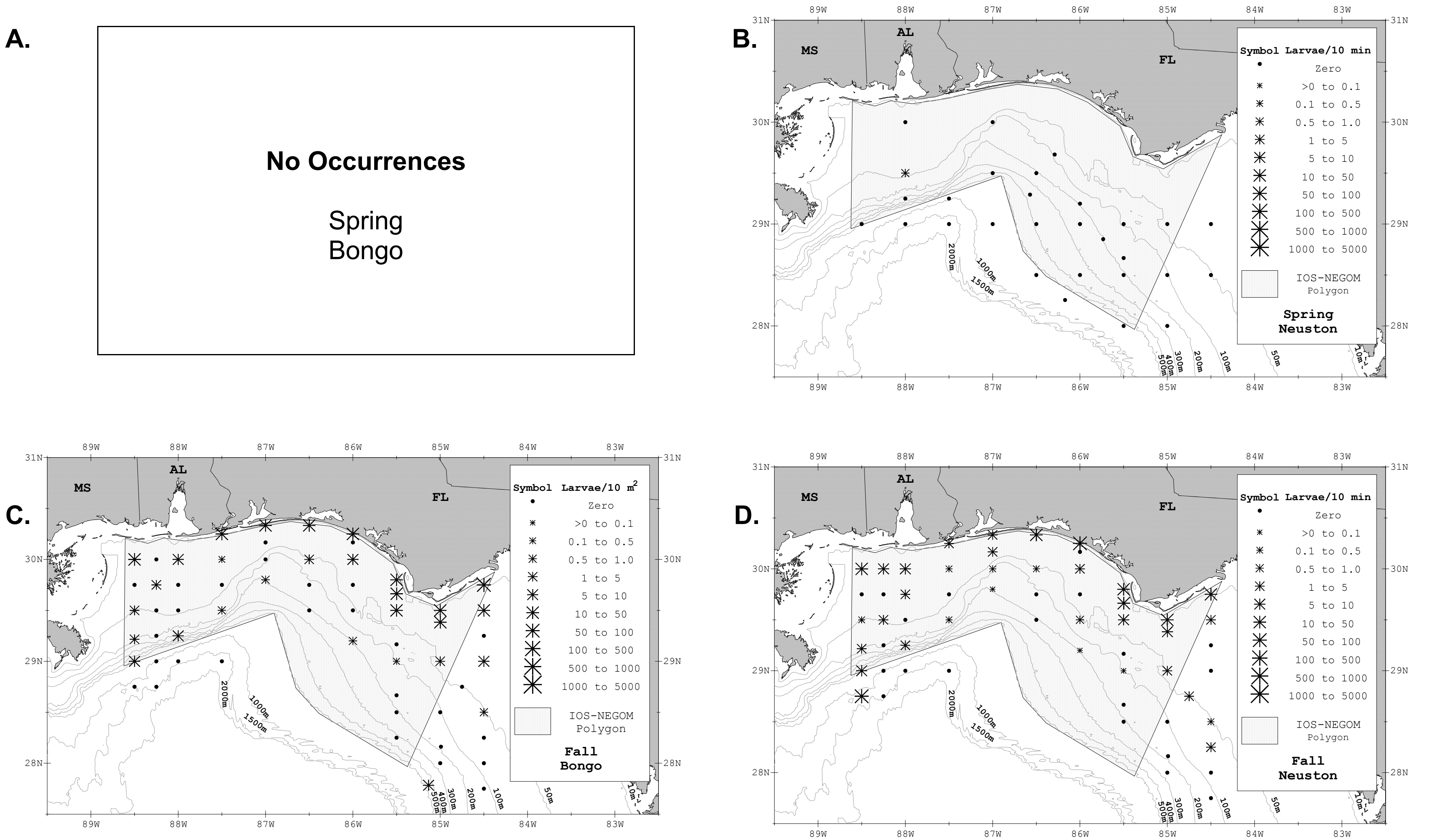


Figure 32. Occurrence and mean abundance of Atlantic bumper, *Chloroscombrus chrysurus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

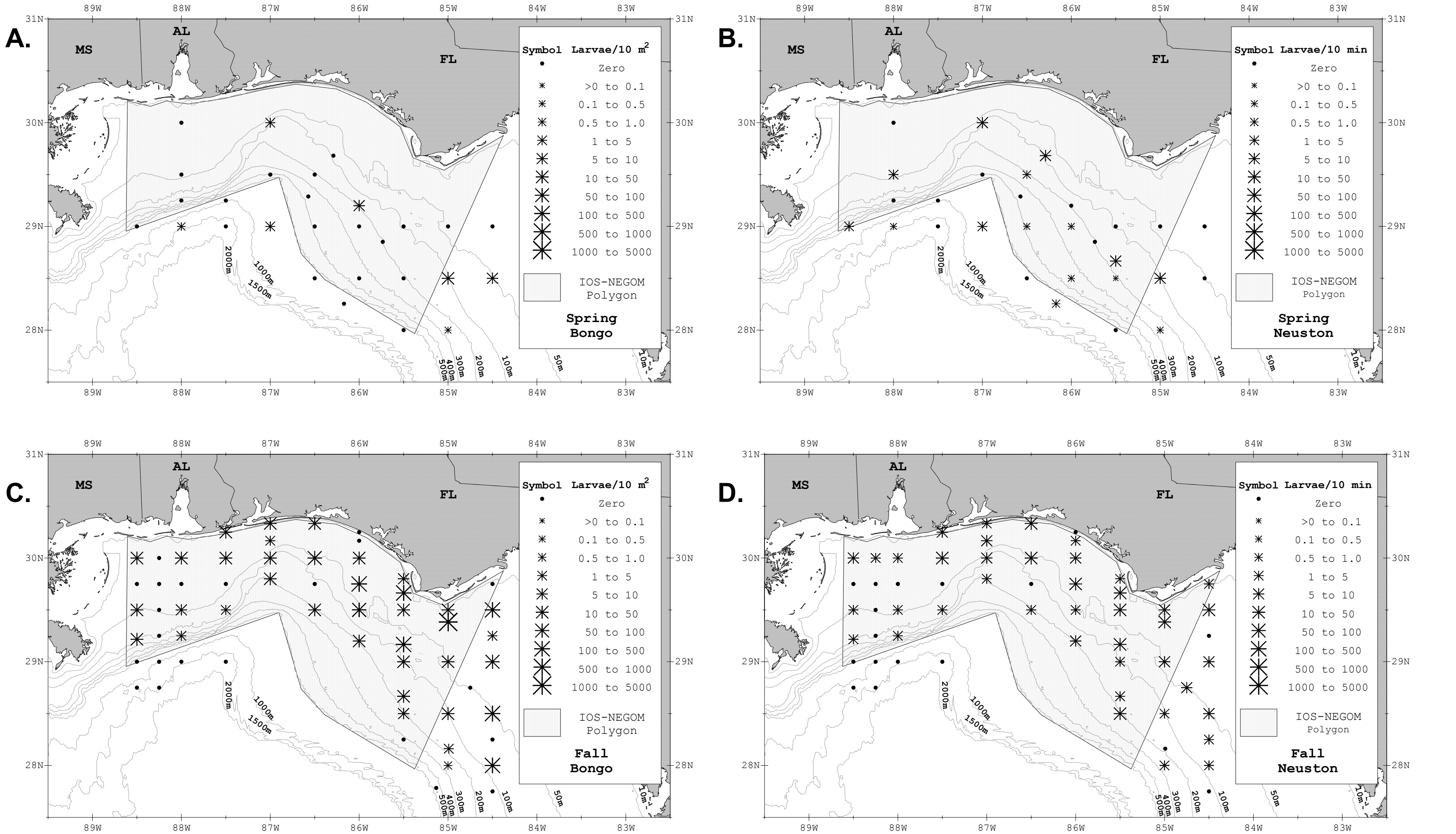


Figure 33. Occurrence and mean abundance of scad larvae, genus *Decapterus*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

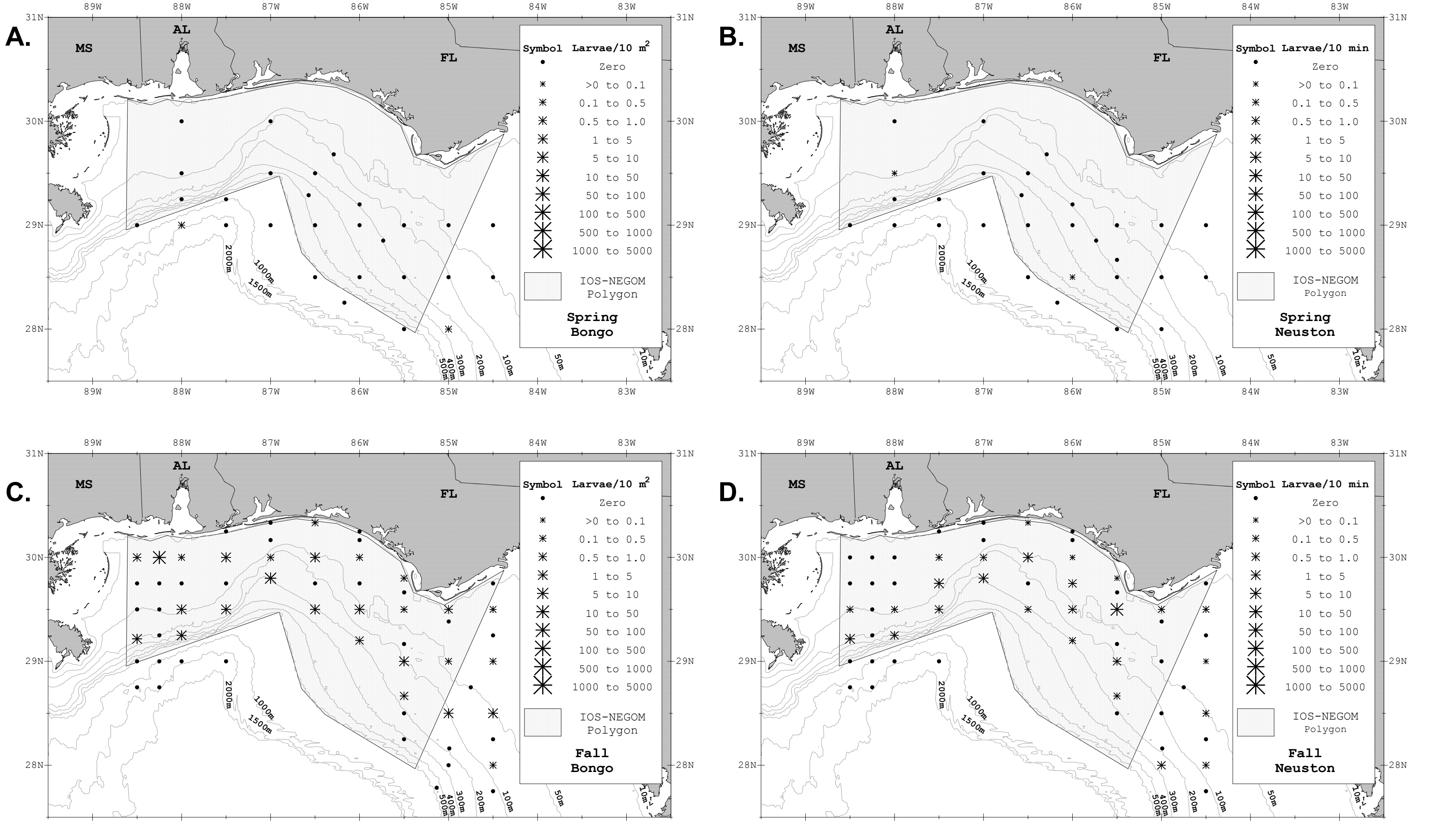


Figure 34. Occurrence and mean abundance of bigeye scad, *Selar crumenophthalmus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

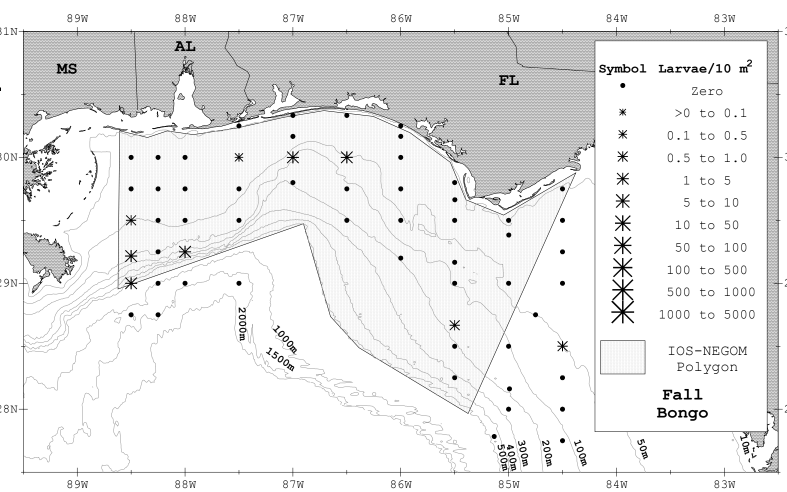
Spring
Bongo

B.

No Occurrences

Spring
Neuston

C.



D.

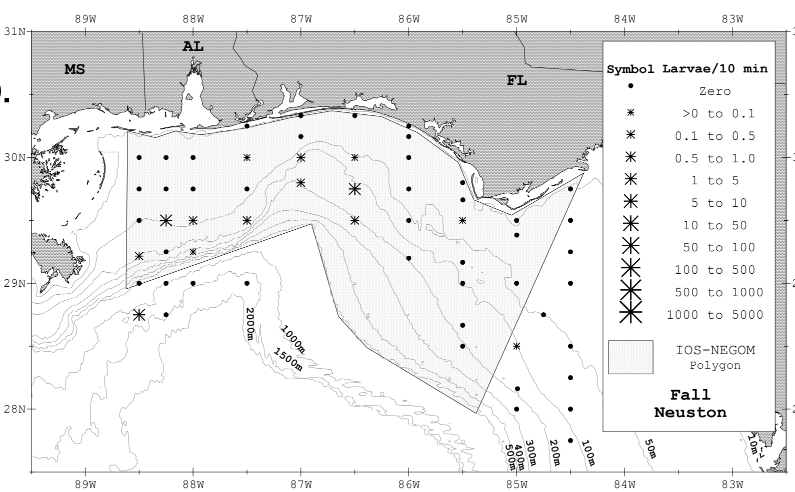


Figure 35. Occurrence and mean abundance of moonfish and lookdown larvae, genus *Selene*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

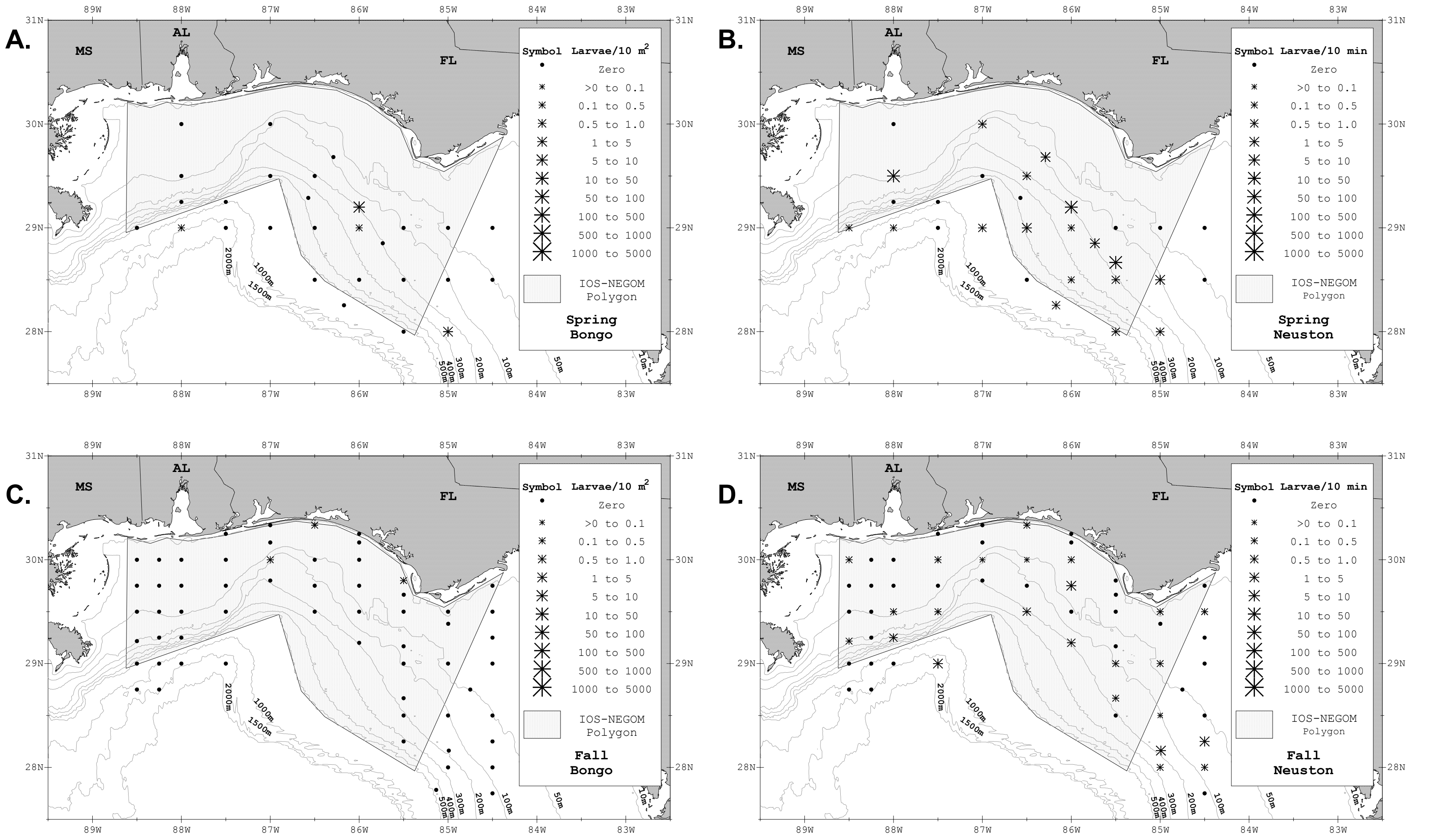


Figure 36. Occurrence and mean abundance of amberjack larvae, genus *Seriola*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

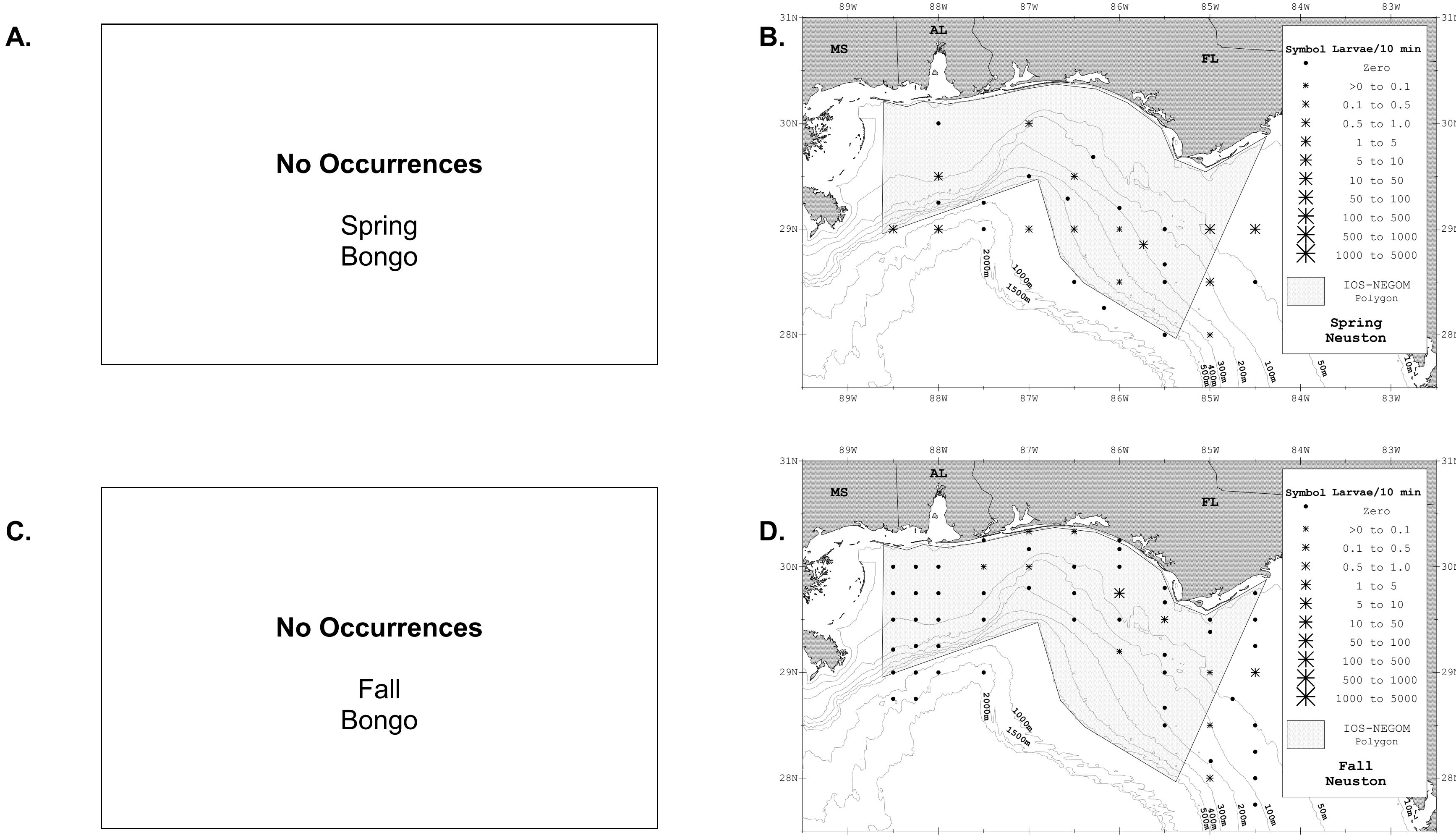
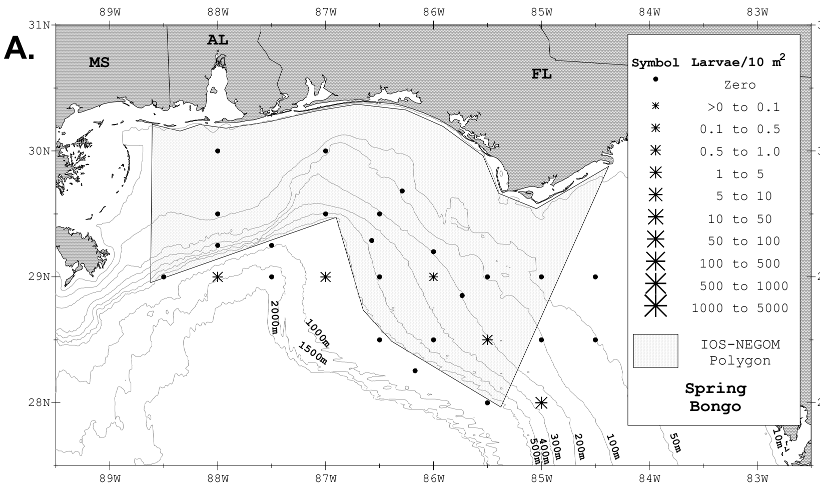
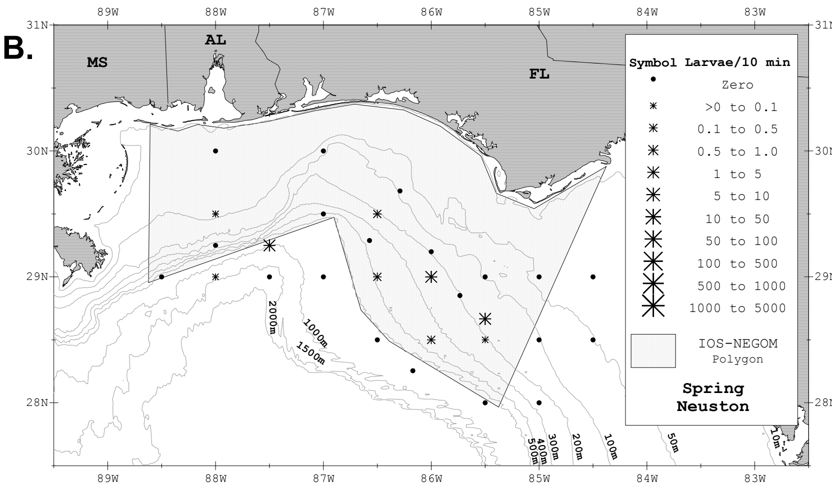


Figure 37. Occurrence and mean abundance of pompano larvae, genus *Trachinotus*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.



B.



C.

No Occurrences

Fall
Bongo

D.

No Occurrences

Fall
Neuston

Figure 38. Occurrence and mean abundance of rough scad, *Trachurus lathami*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

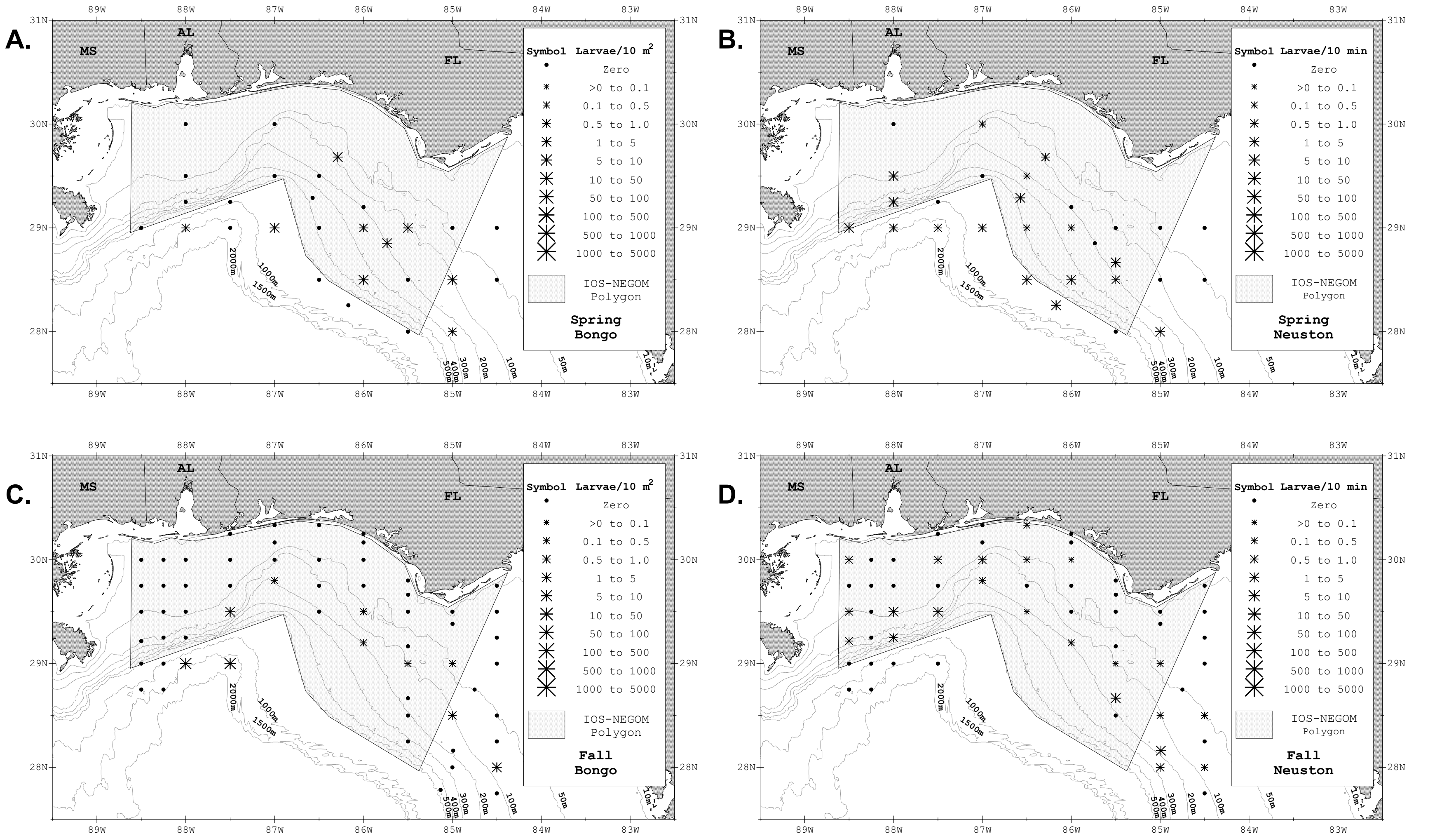


Figure 39. Occurrence and mean abundance of dolphin (Coryphaenidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

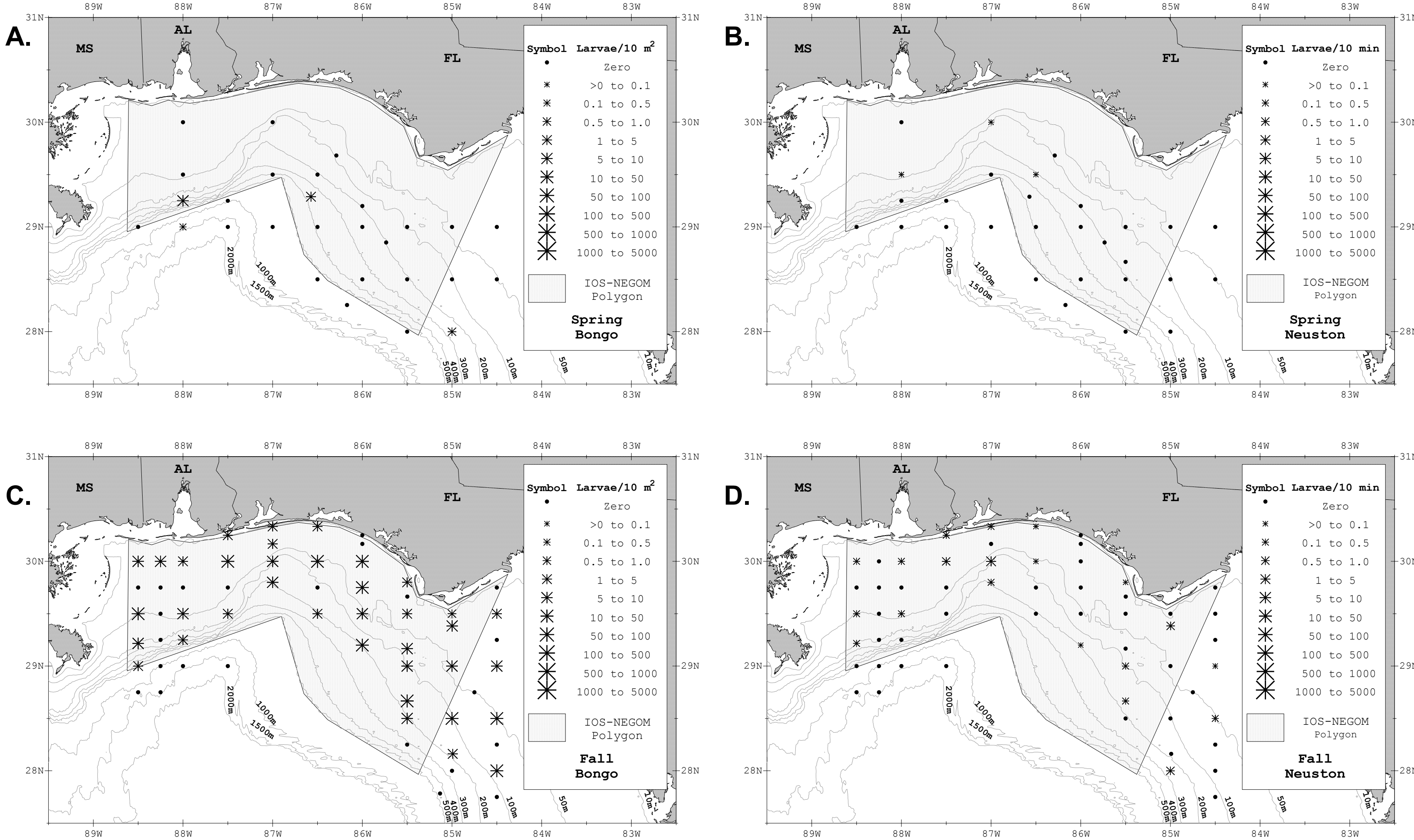


Figure 40. Occurrence and mean abundance of snapper (Lutjanidae) larvae (<3.0mm) at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

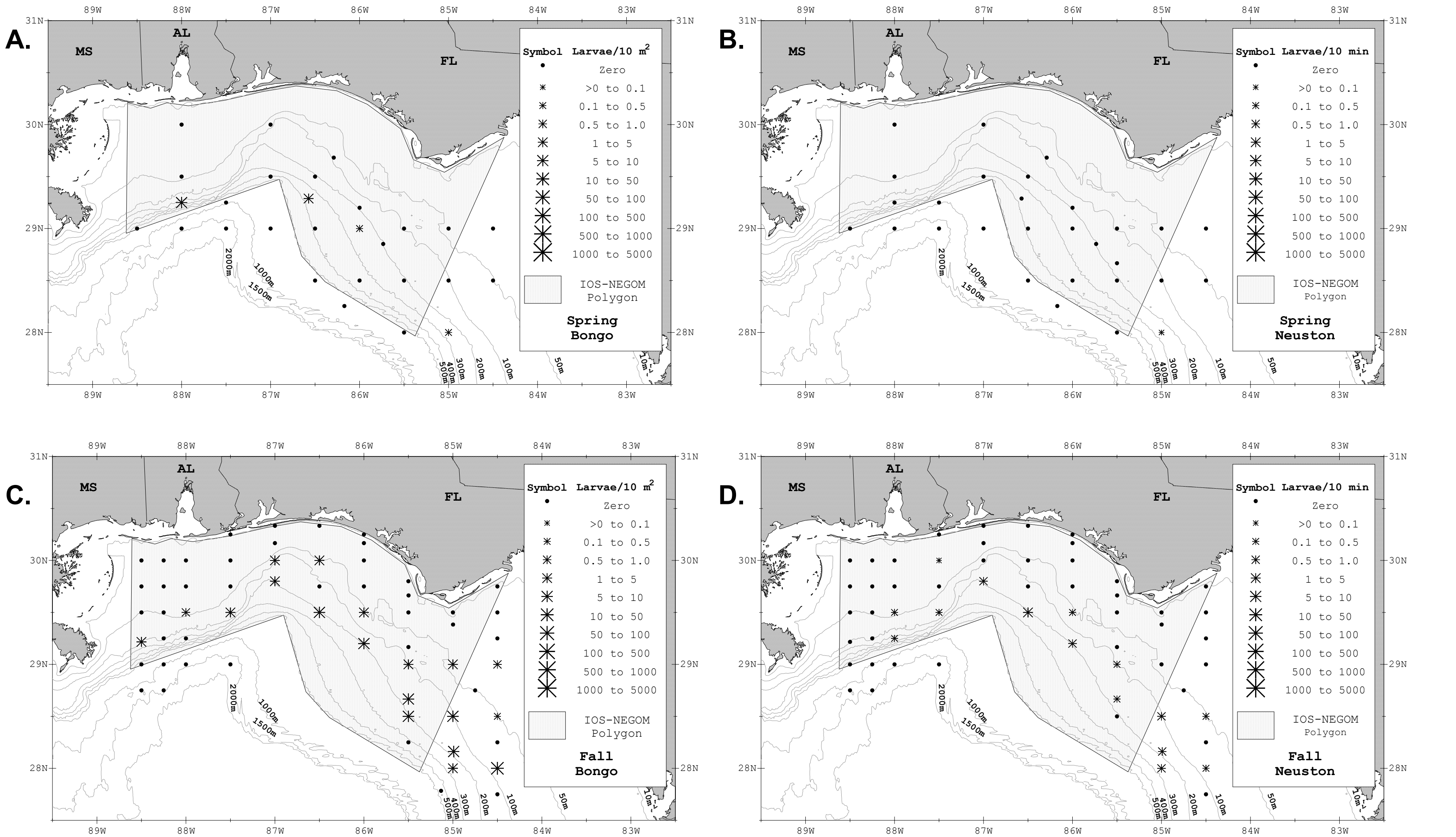


Figure 41. Occurrence and mean abundance of wenchman, *Pristipomoides aquilonaris*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

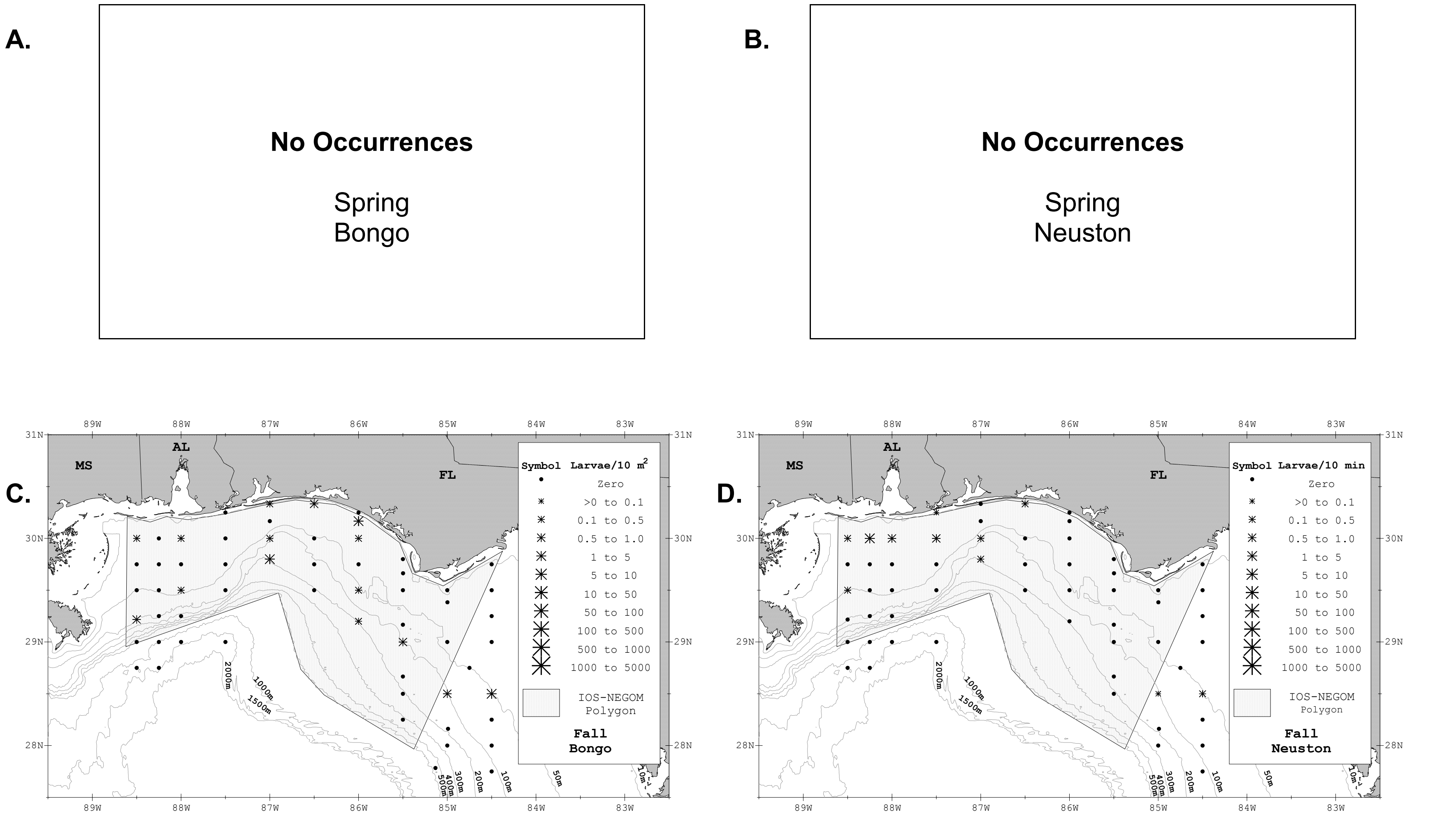


Figure 42. Occurrence and mean abundance of snapper larvae, genus *Lutjanus*, at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

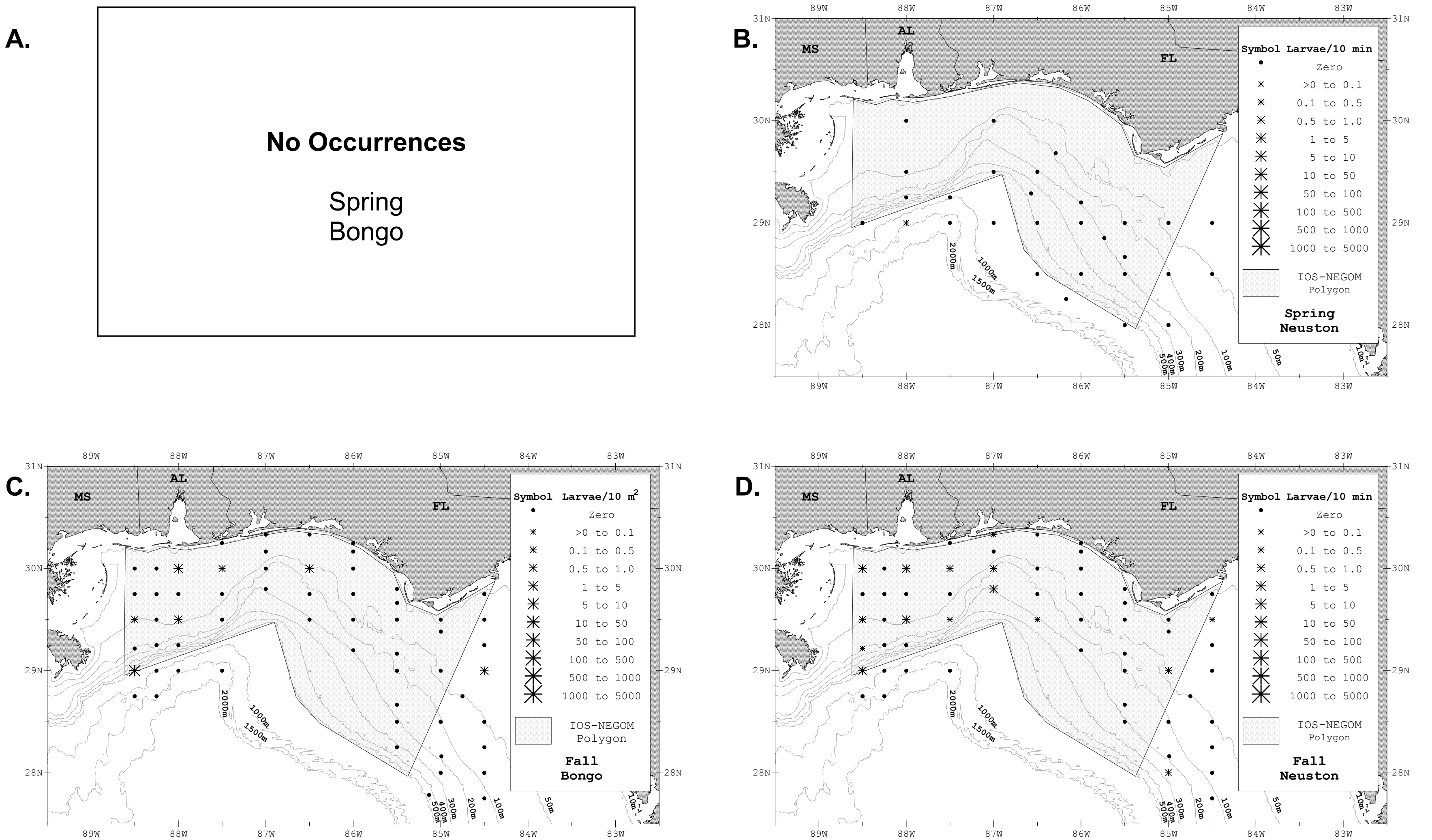


Figure 43. Occurrence and mean abundance of red snapper, *Lutjanus campechanus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

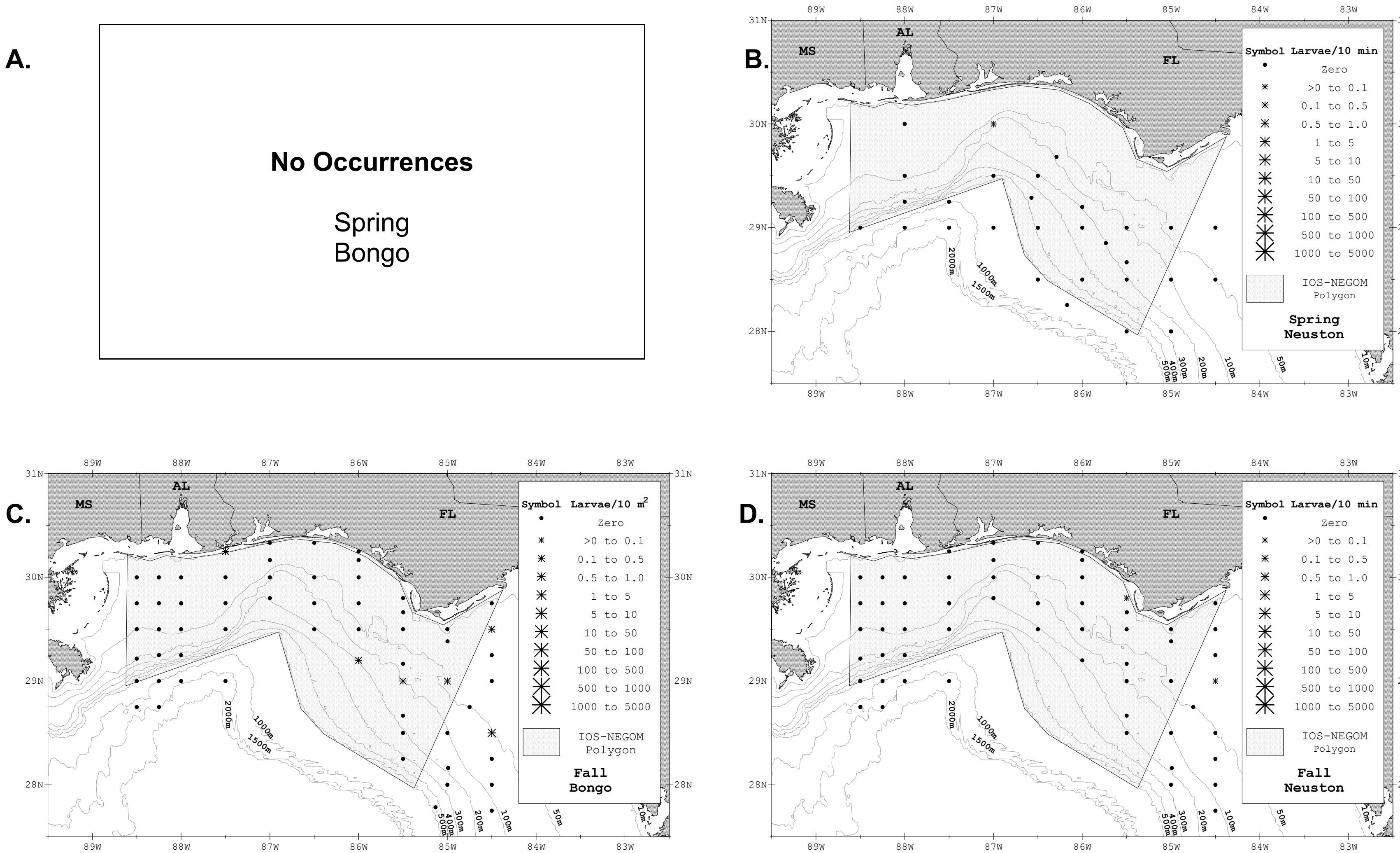


Figure 44. Occurrence and mean abundance of gray snapper, *Lutjanus griseus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

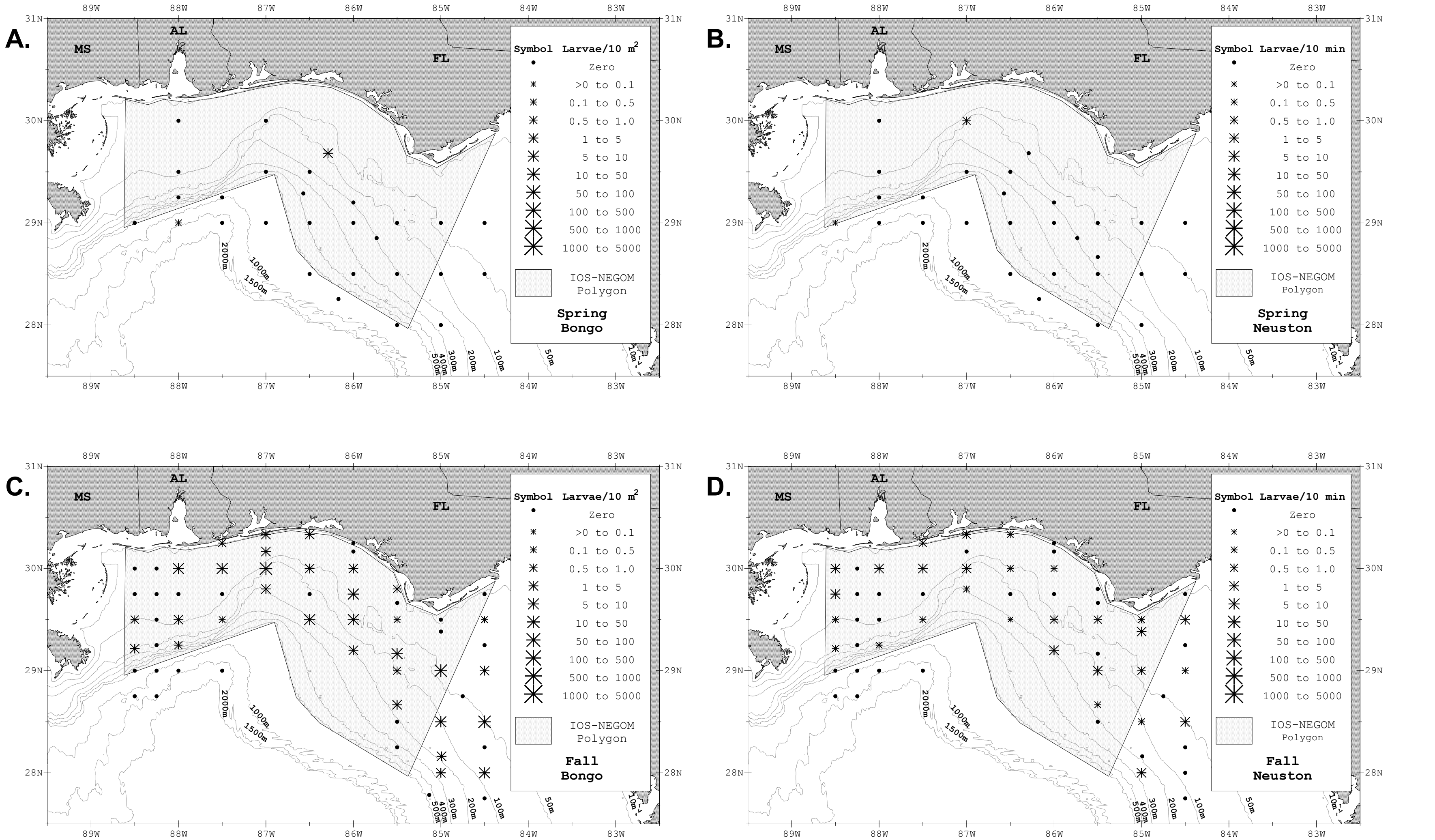


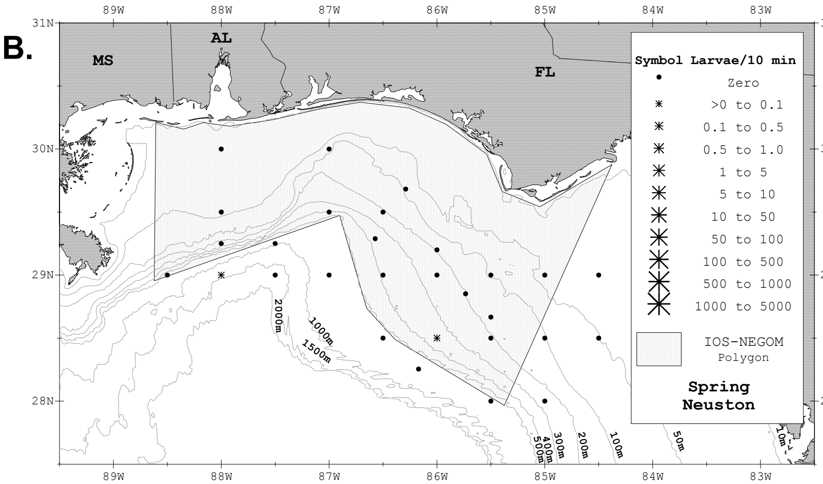
Figure 45. Occurrence and mean abundance of vermillion snapper, *Rhomboplites aurorubens*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

Spring
Bongo

B.



C.

No Occurrences

Fall
Bongo

D.

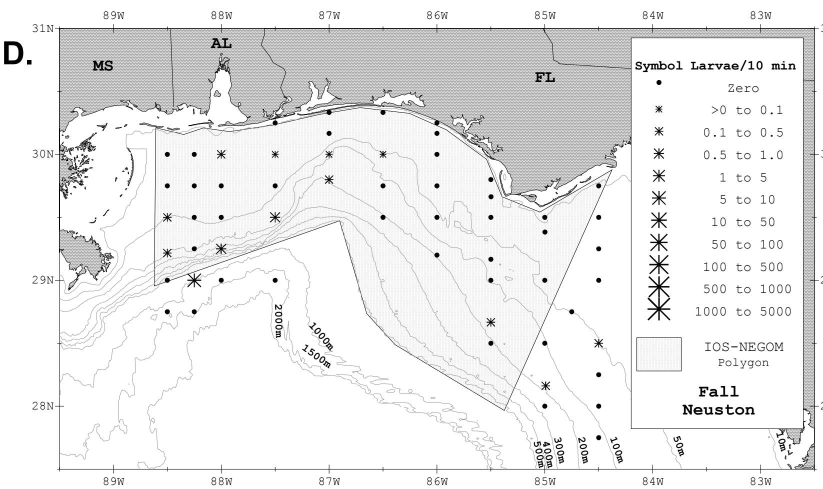


Figure 46. Occurrence and mean abundance of tripletail, *Lobotes surinamensis*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

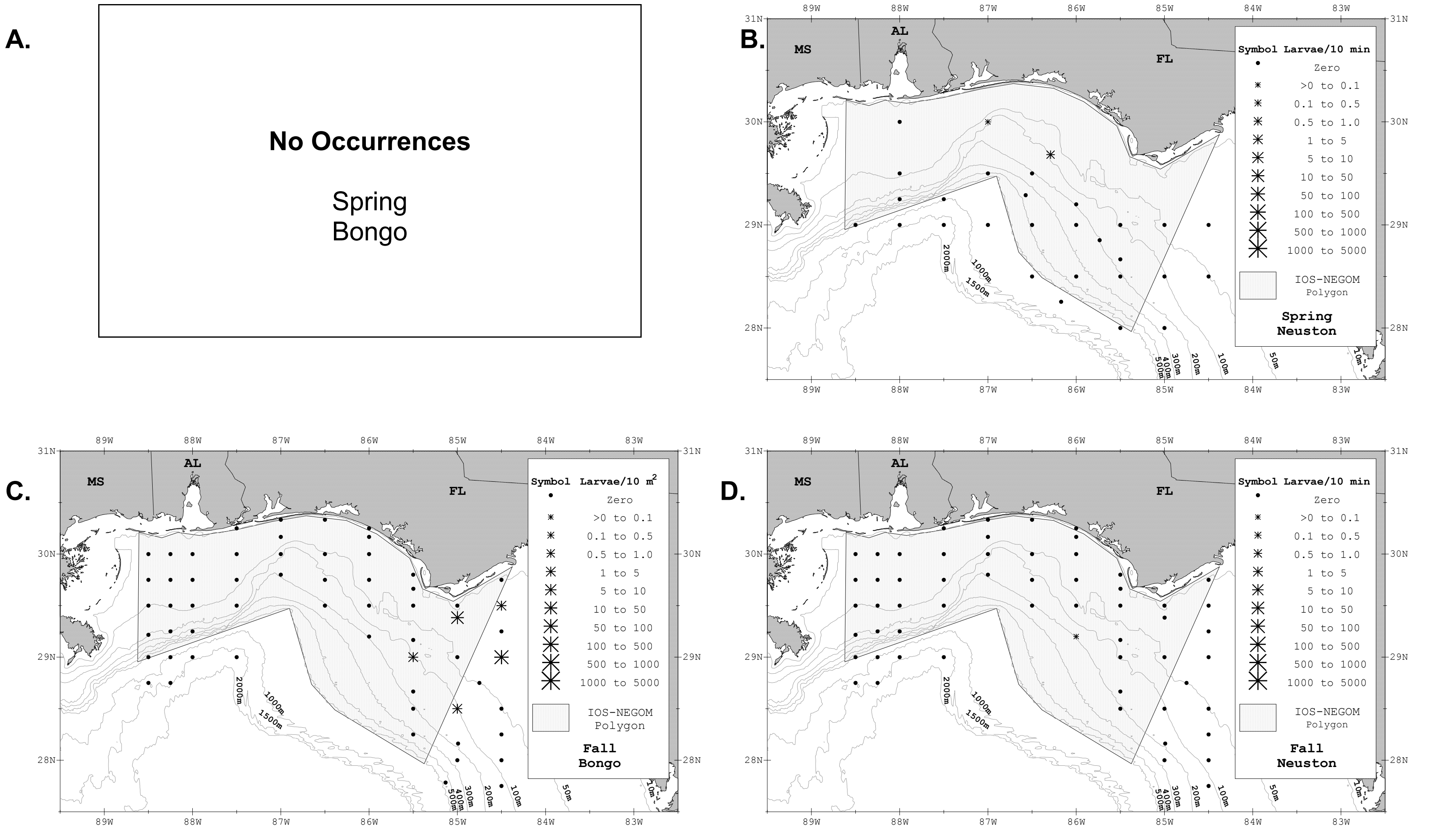


Figure 47. Occurrence and mean abundance of grunt (Haemulidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

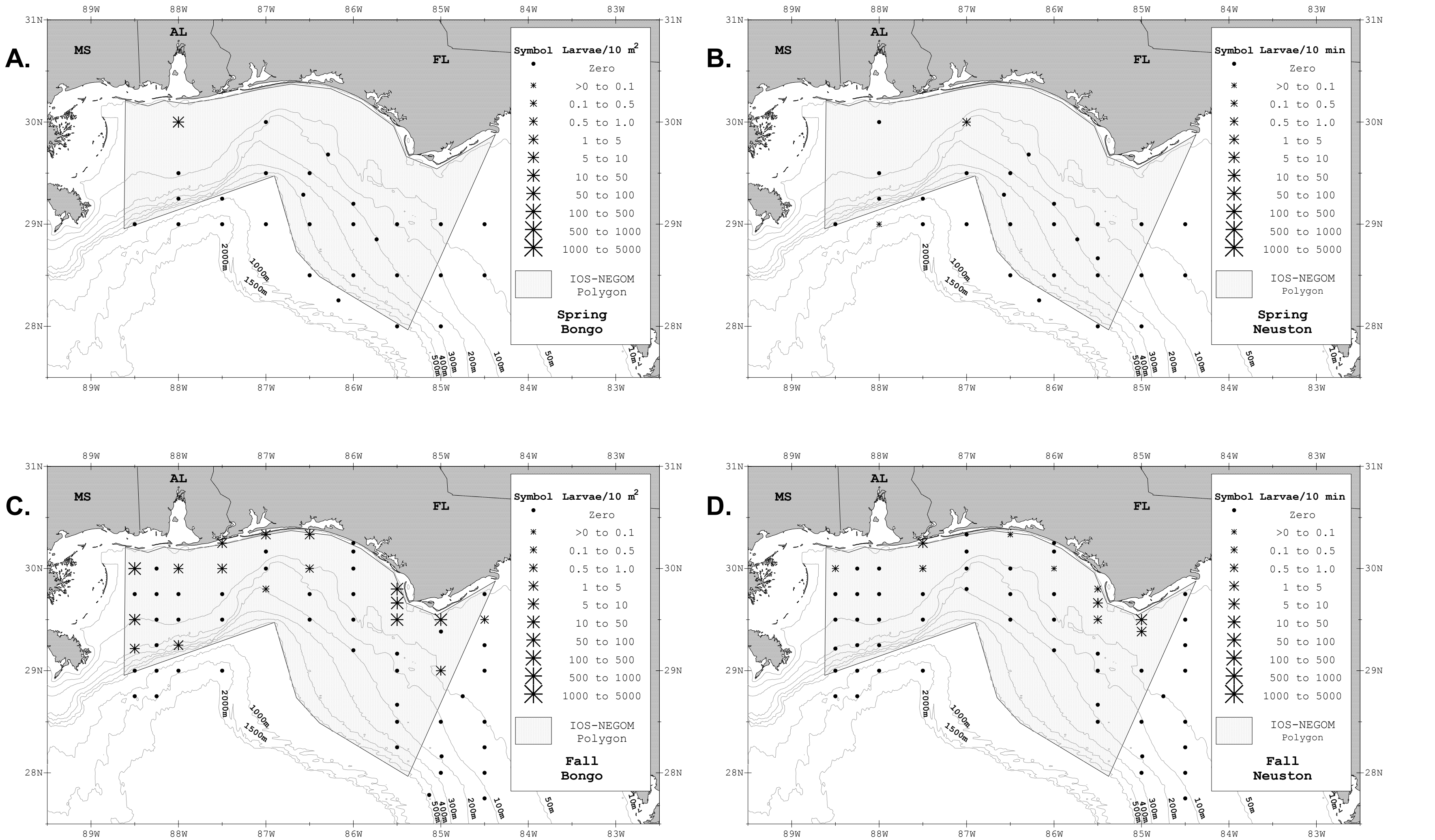


Figure 48. Occurrence and mean abundance of seatrout (*Cynoscion* spp.) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

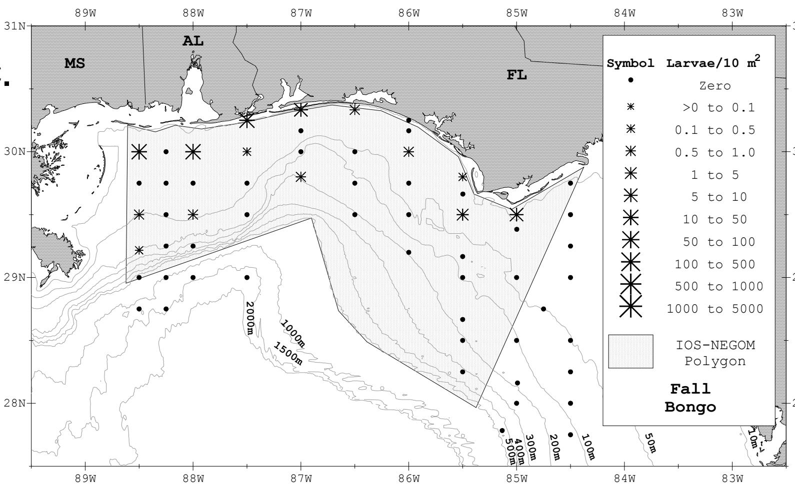
Spring
Bongo

B.

No Occurrences

Spring
Neuston

C.



D.

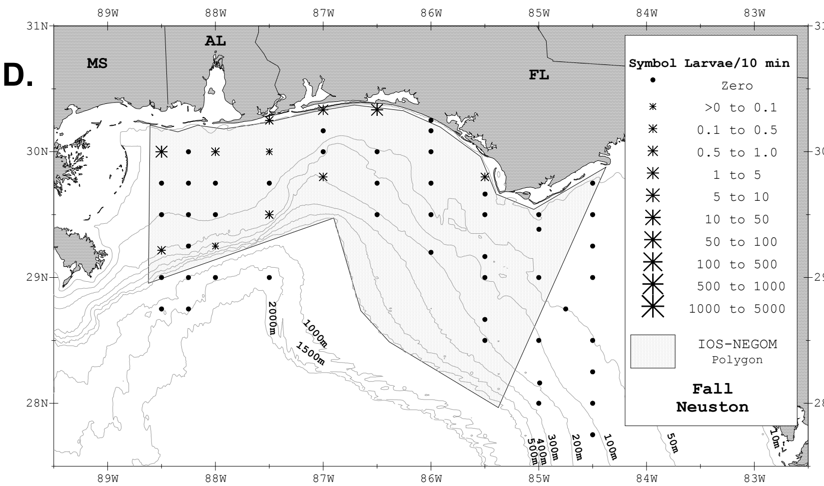


Figure 49. Occurrence and mean abundance of red drum, *Sciaenops ocellatus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

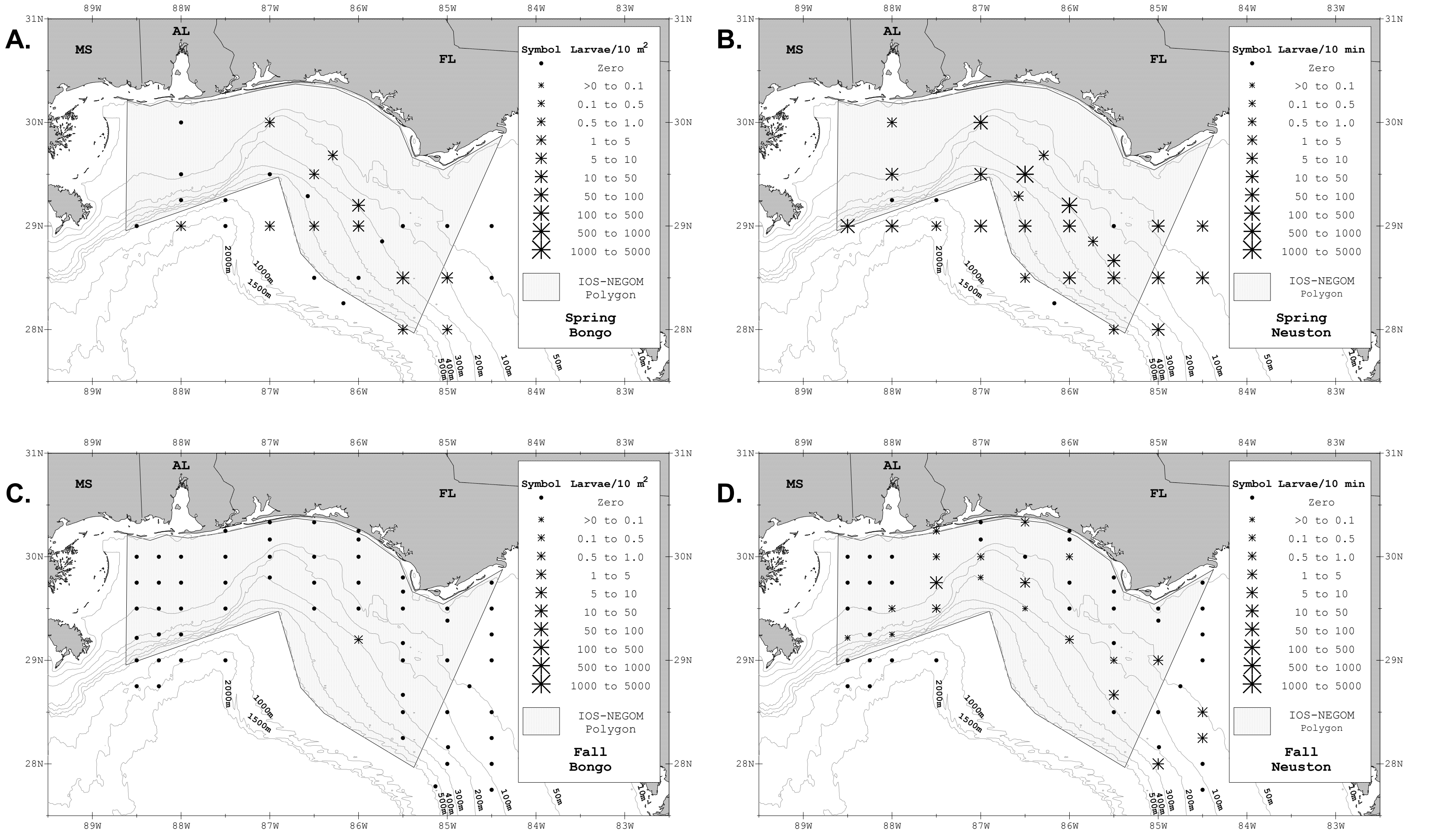


Figure 50. Occurrence and mean abundance of goatfish (Mullidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

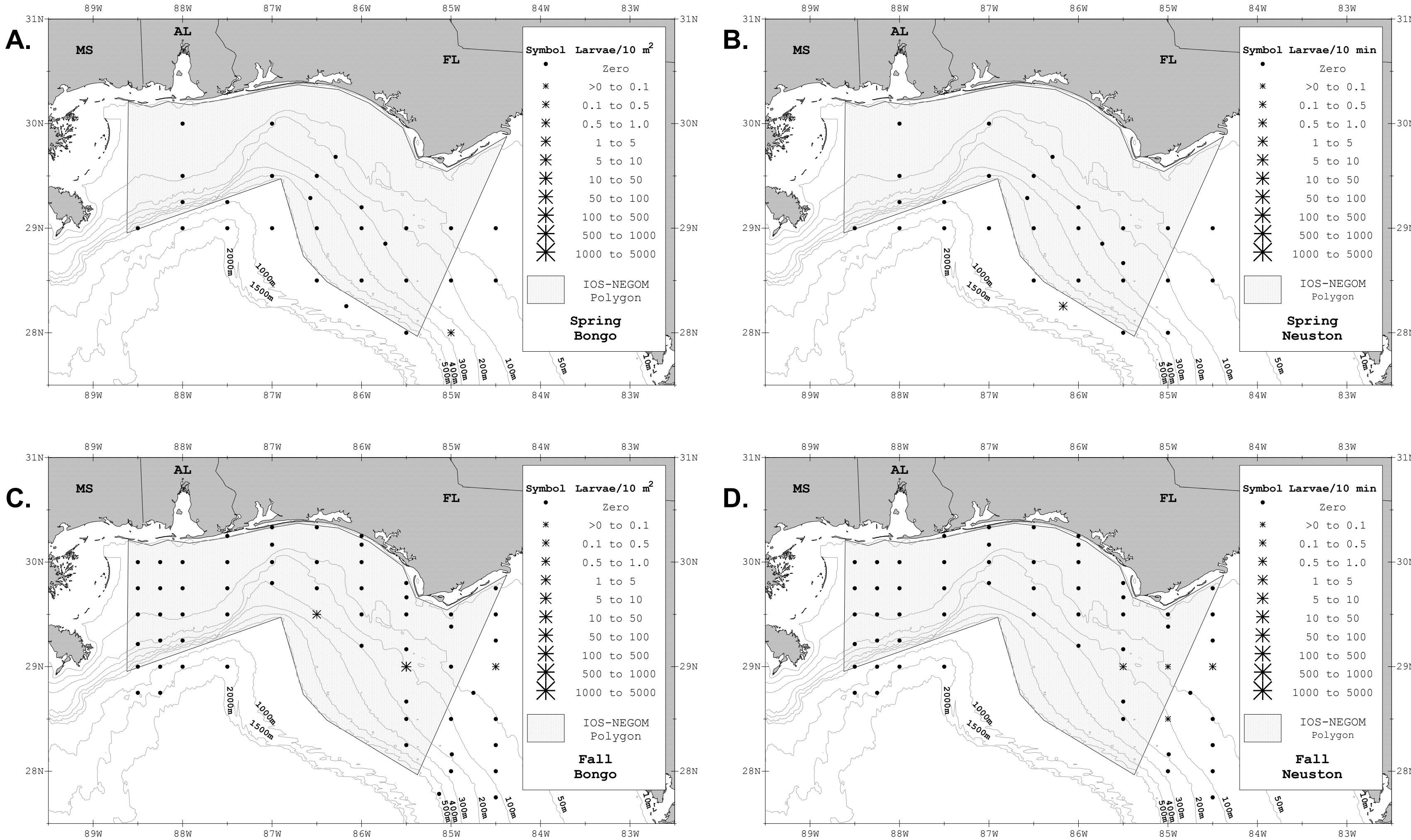


Figure 51. Occurrence and mean abundance of butterflyfish (Chaetodontidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

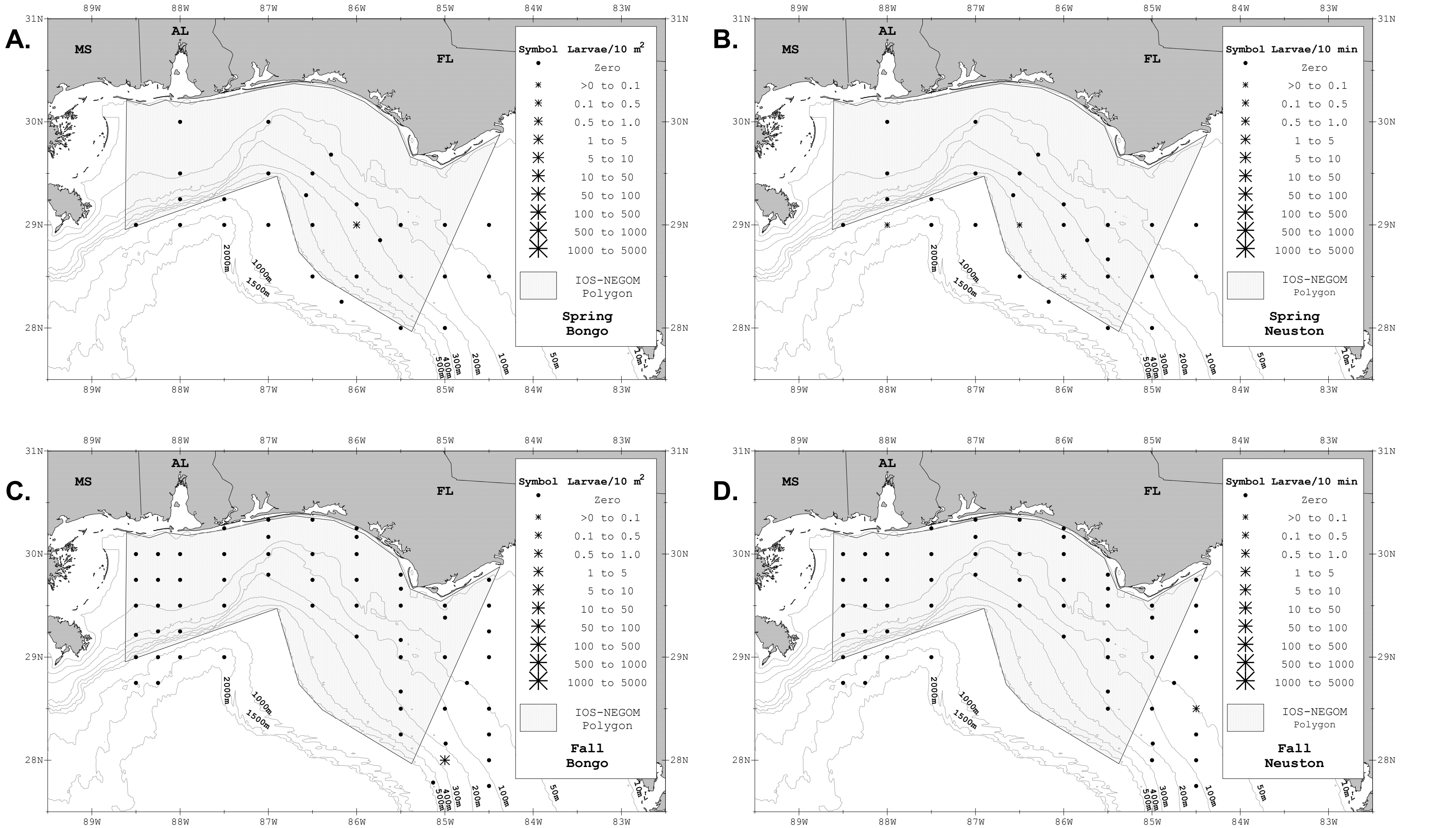


Figure 52. Occurrence and mean abundance of angelfish (Pomacanthidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

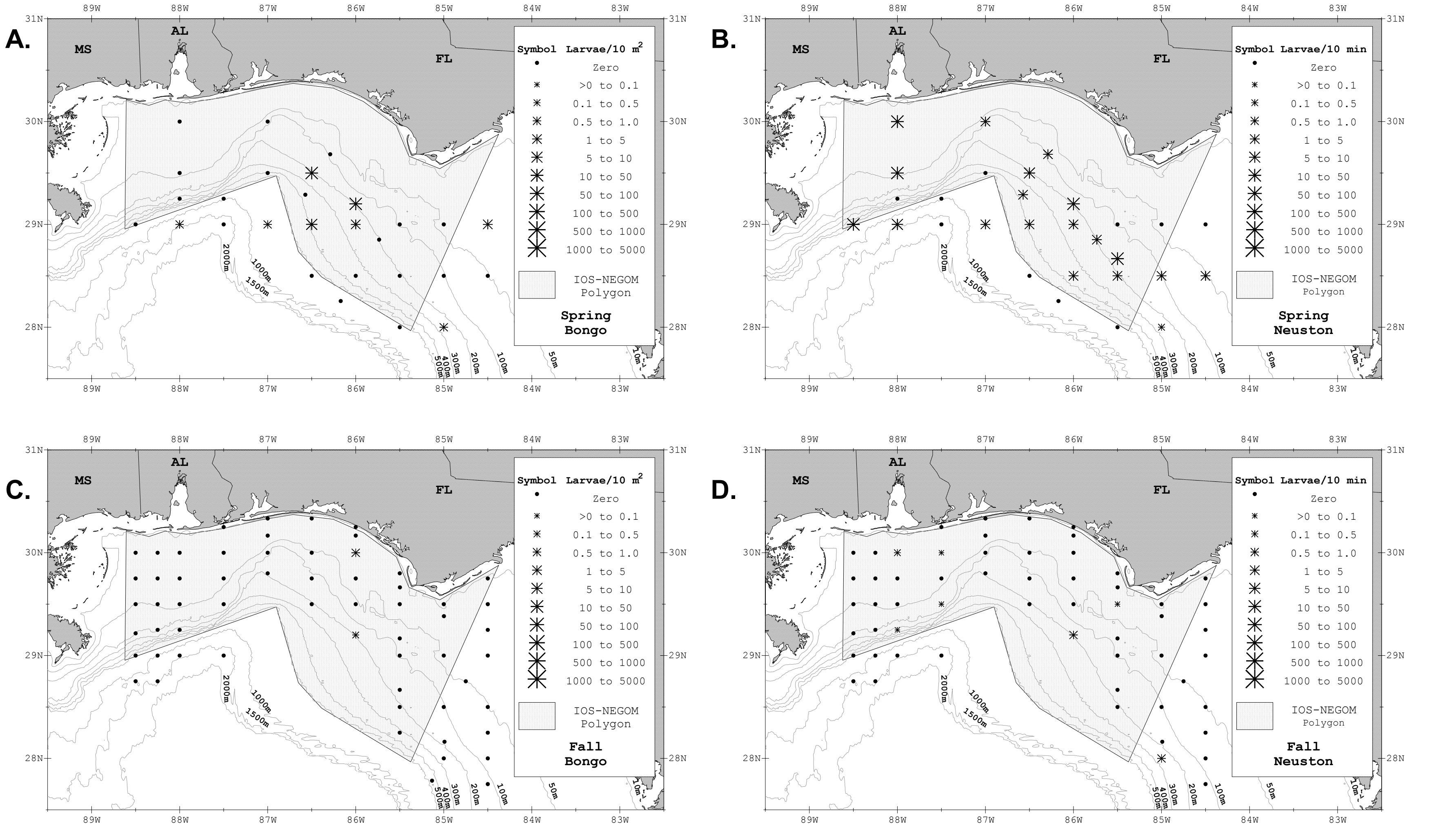


Figure 53. Occurrence and mean abundance of mullet (Mugilidae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

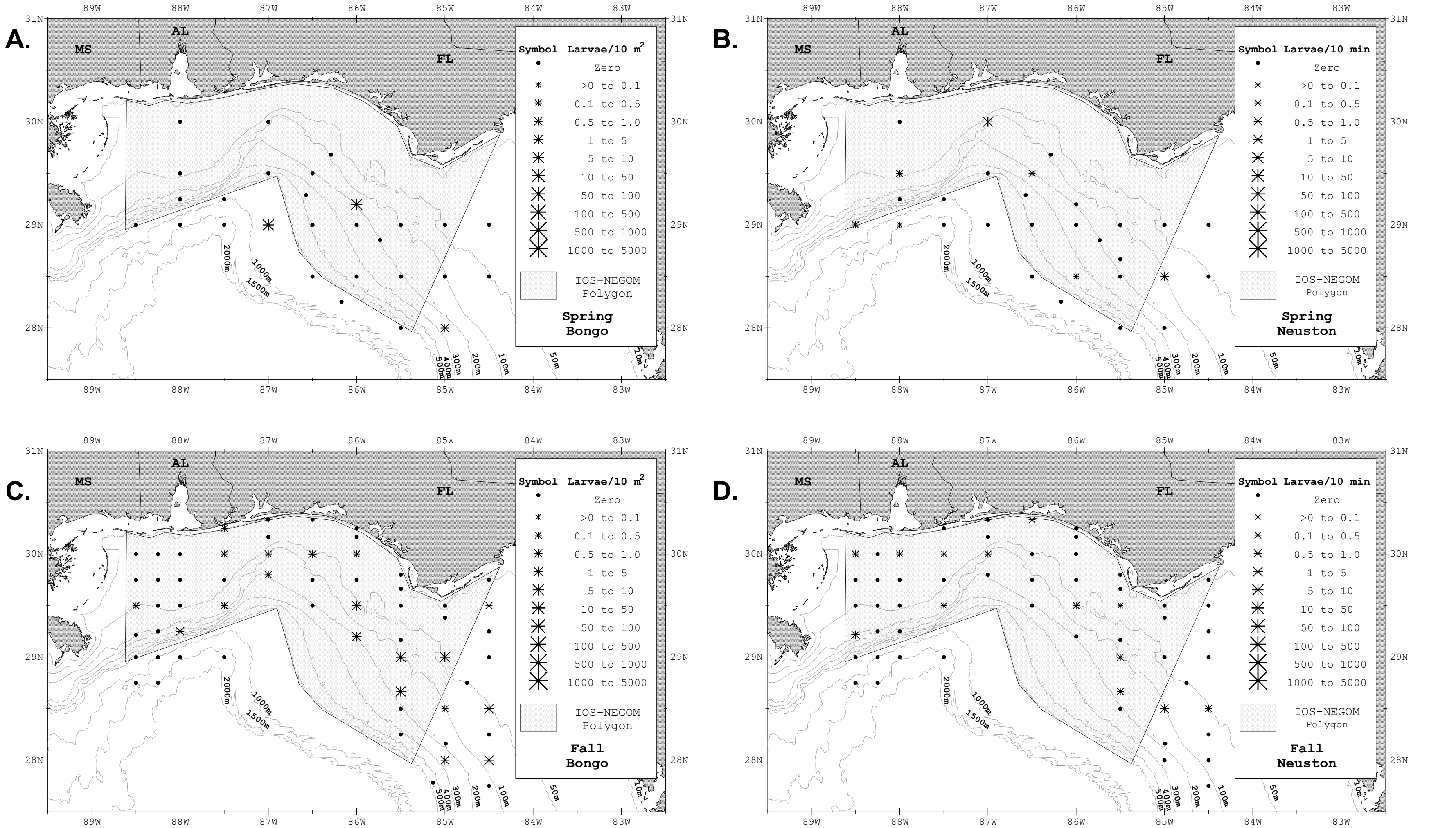


Figure 54. Occurrence and mean abundance of damselfish (Pomacentridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

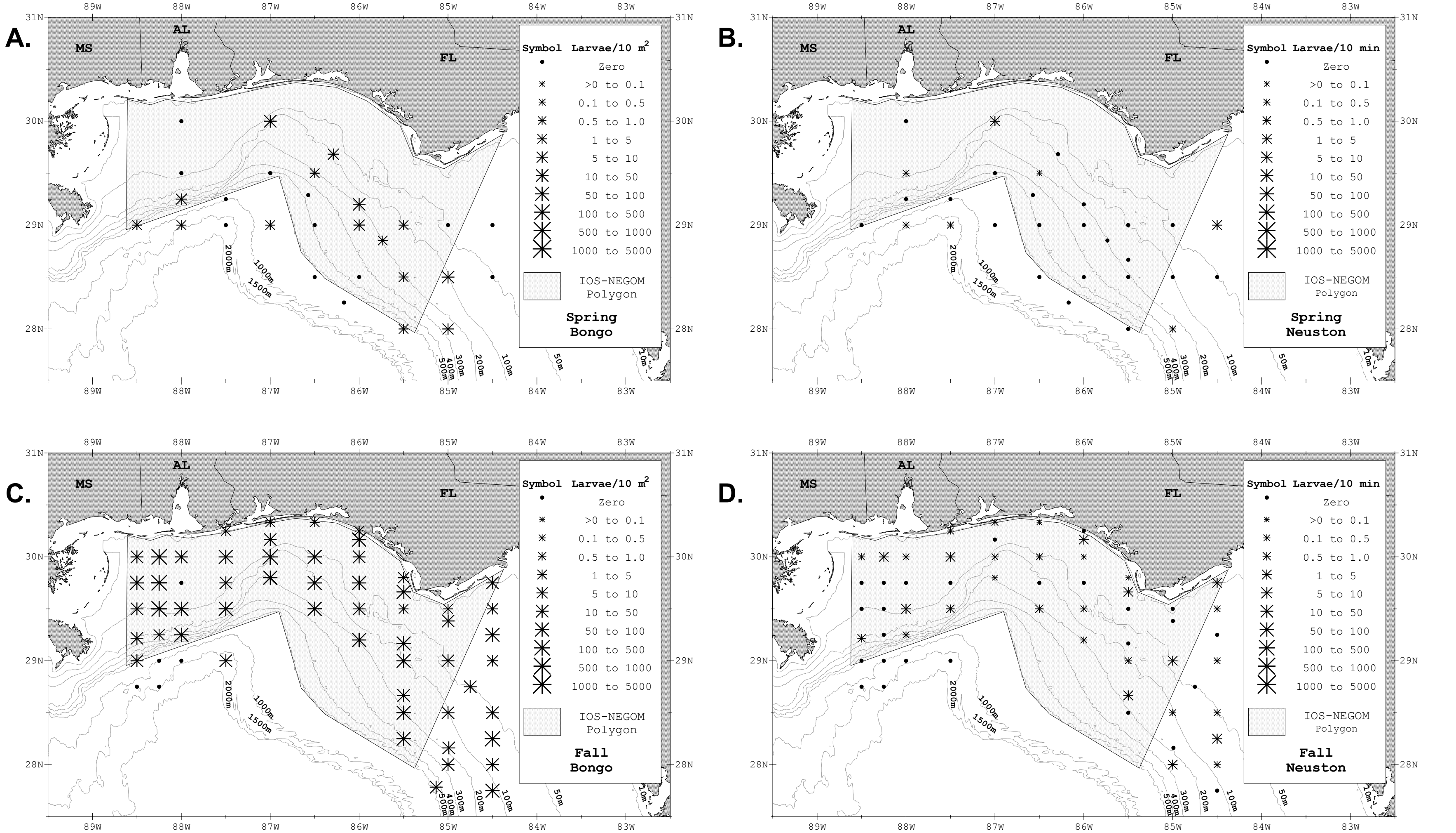


Figure 55. Occurrence and mean abundance of wrasse (Labridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

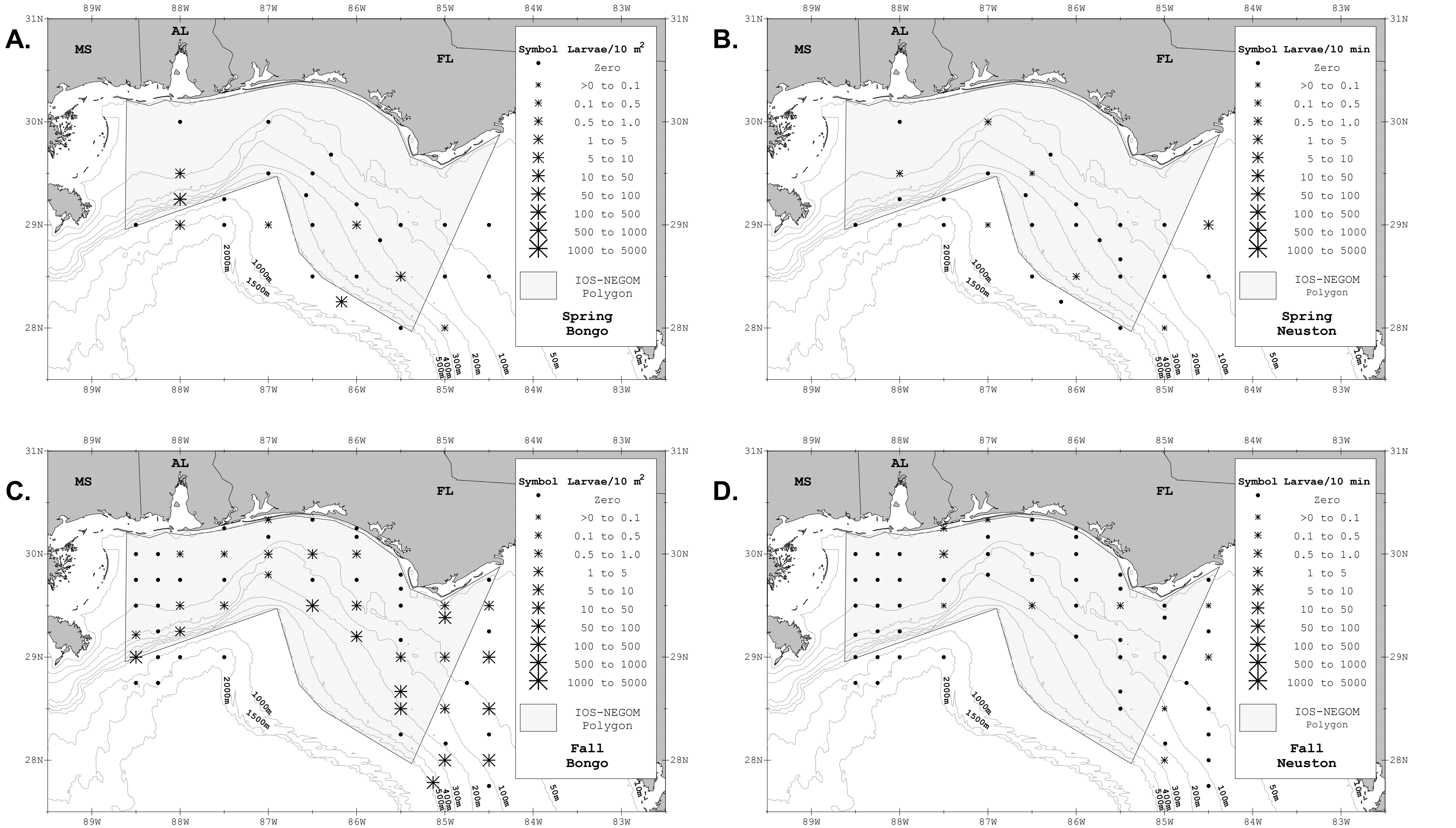


Figure 56. Occurrence and mean abundance of parrotfish (Scaridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

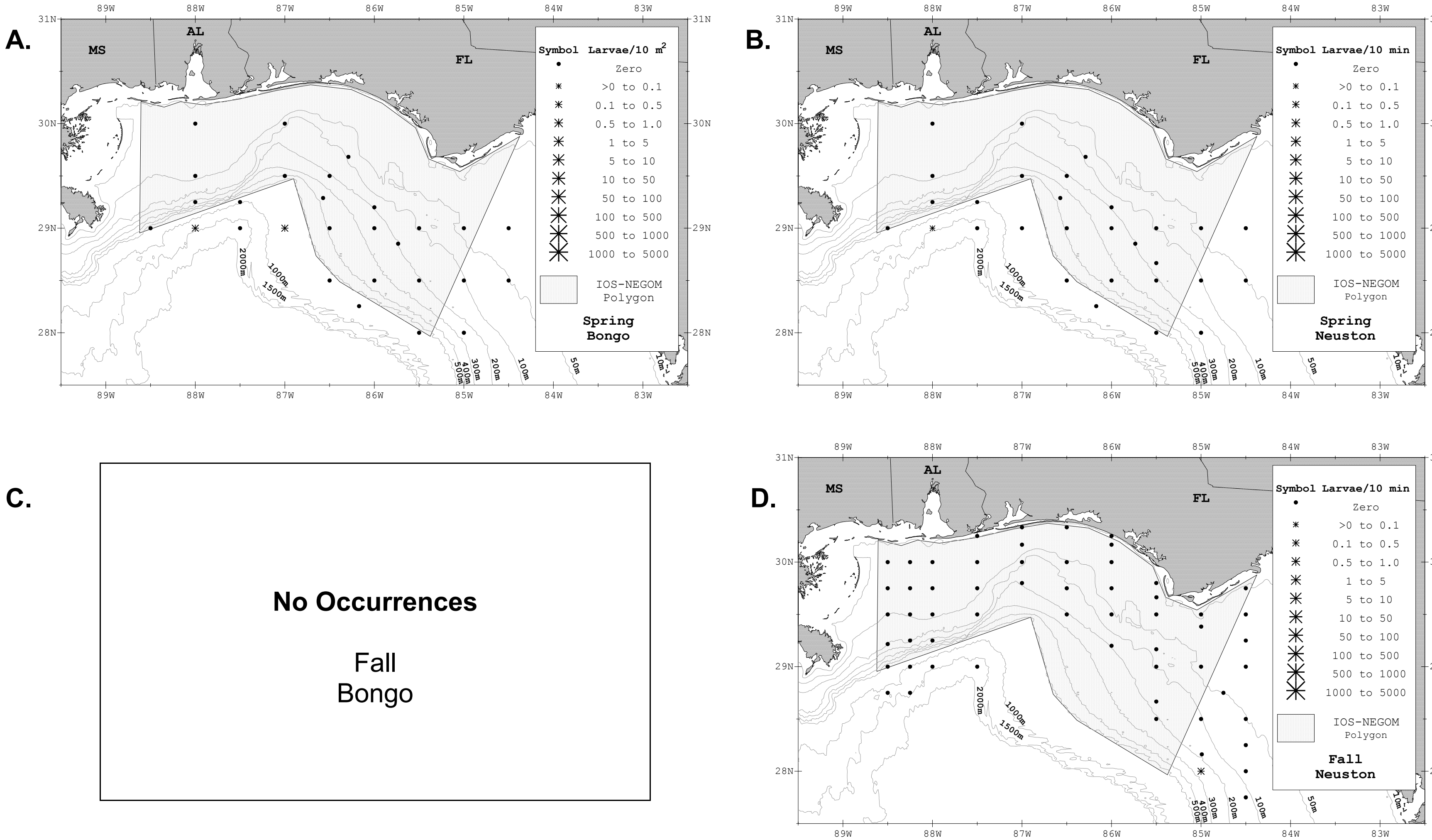


Figure 57. Occurrence and mean abundance of surgeonfish (Acanthuridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

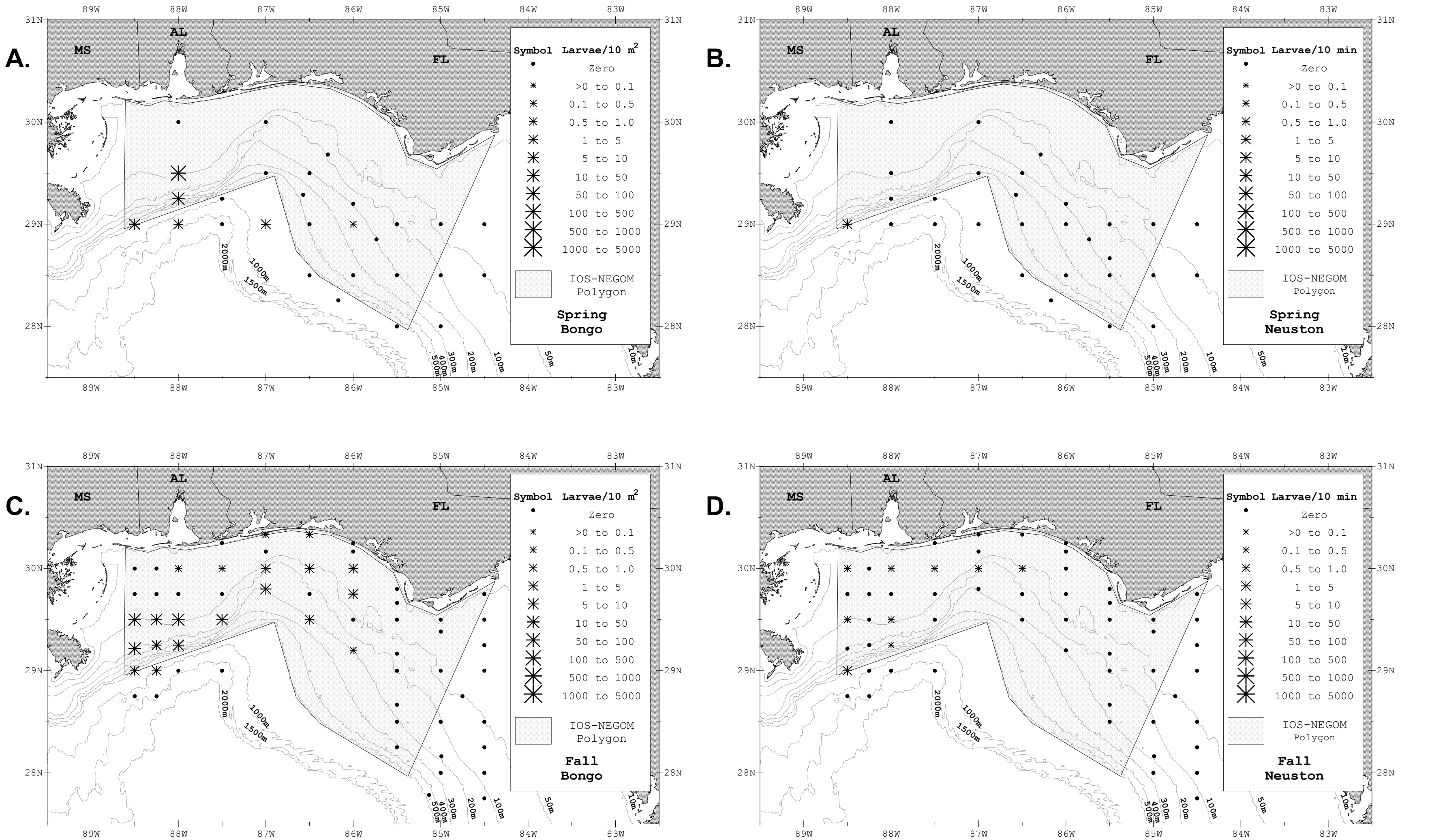


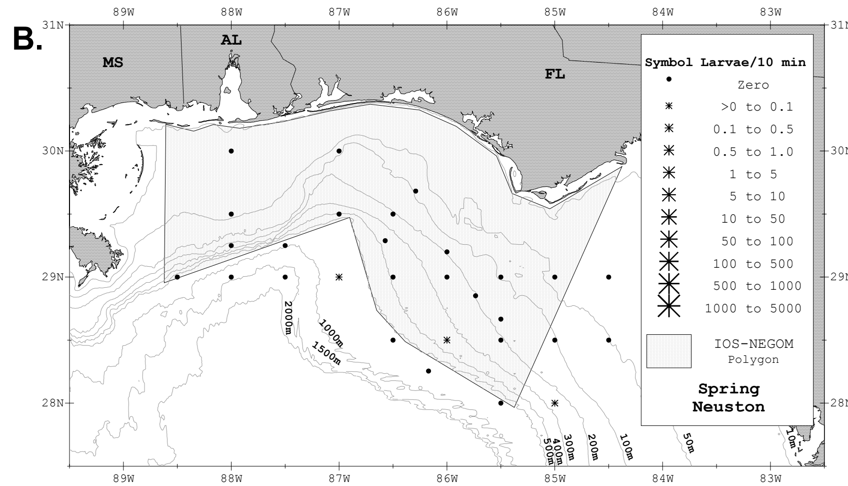
Figure 58. Occurrence and mean abundance of Atlantic cutlassfish, *Trichiurus lepturus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

Spring
Bongo

B.



C.

No Occurrences

Fall
Bongo

D.

No Occurrences

Fall
Neuston

Figure 59. Occurrence and mean abundance of swordfish, *Xiphias gladius*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

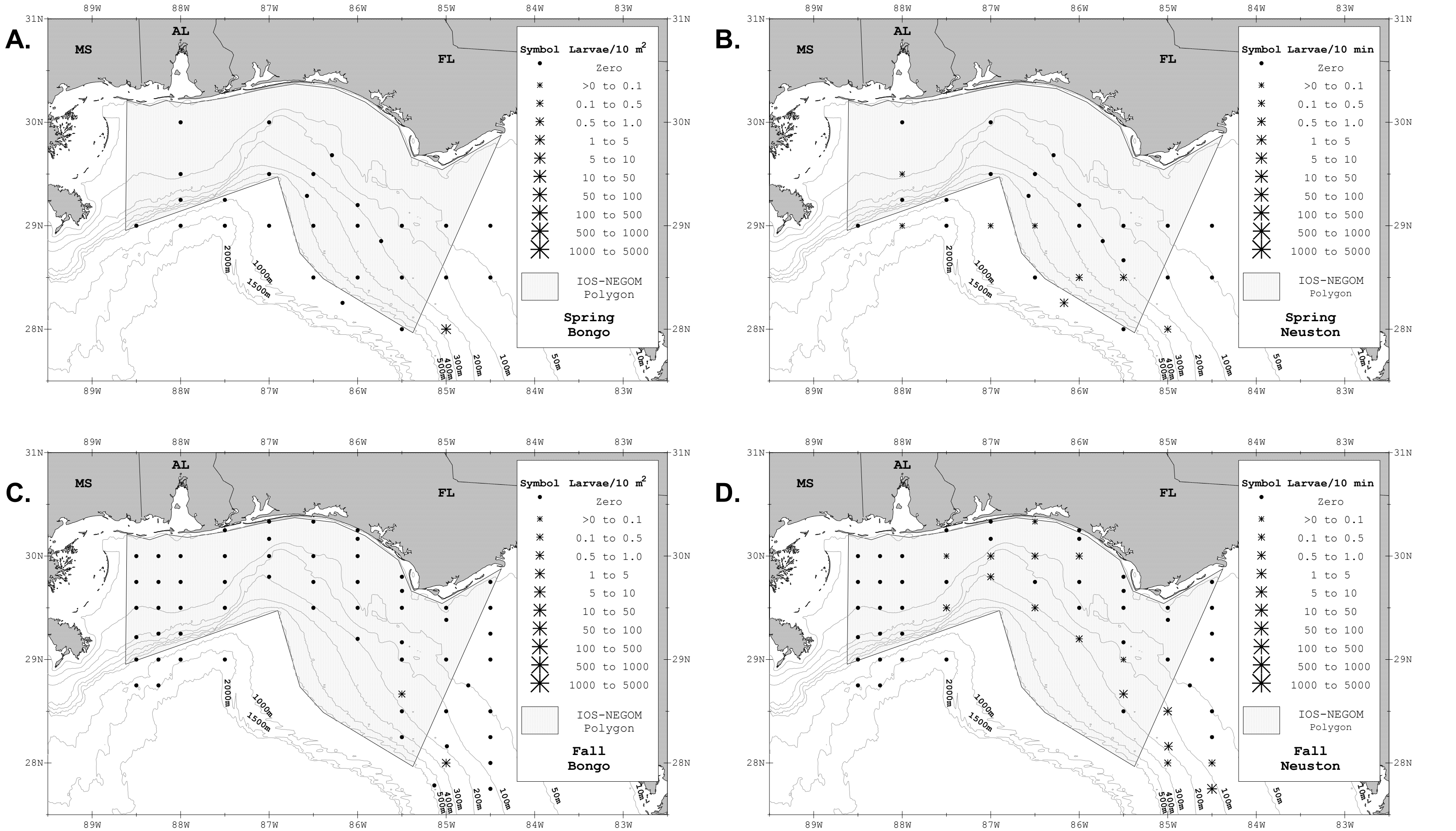


Figure 60. Occurrence and mean abundance of billfish (Istiophoridae) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

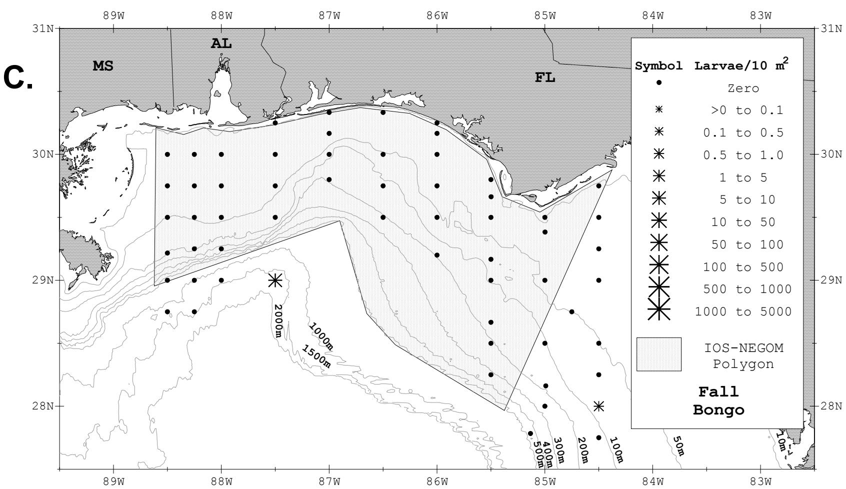
Spring
Bongo

B.

No Occurrences

Spring
Neuston

C.



D.

No Occurrences

Fall
Neuston

Figure 61. Occurrence and mean abundance of wahoo, *Acanthocybium solandri*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

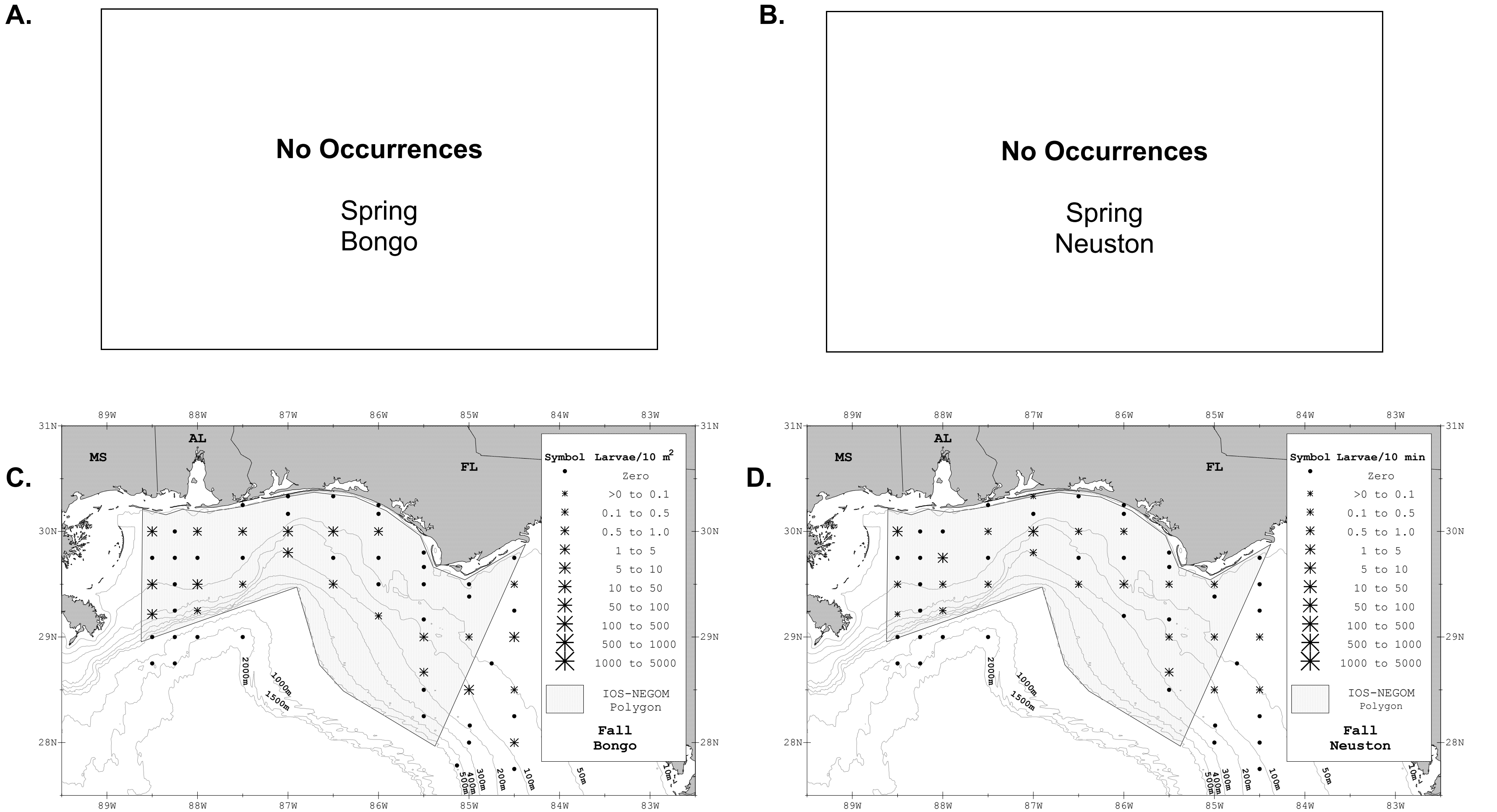


Figure 62. Occurrence and mean abundance of king mackerel, *Scomberomorus cavalla*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

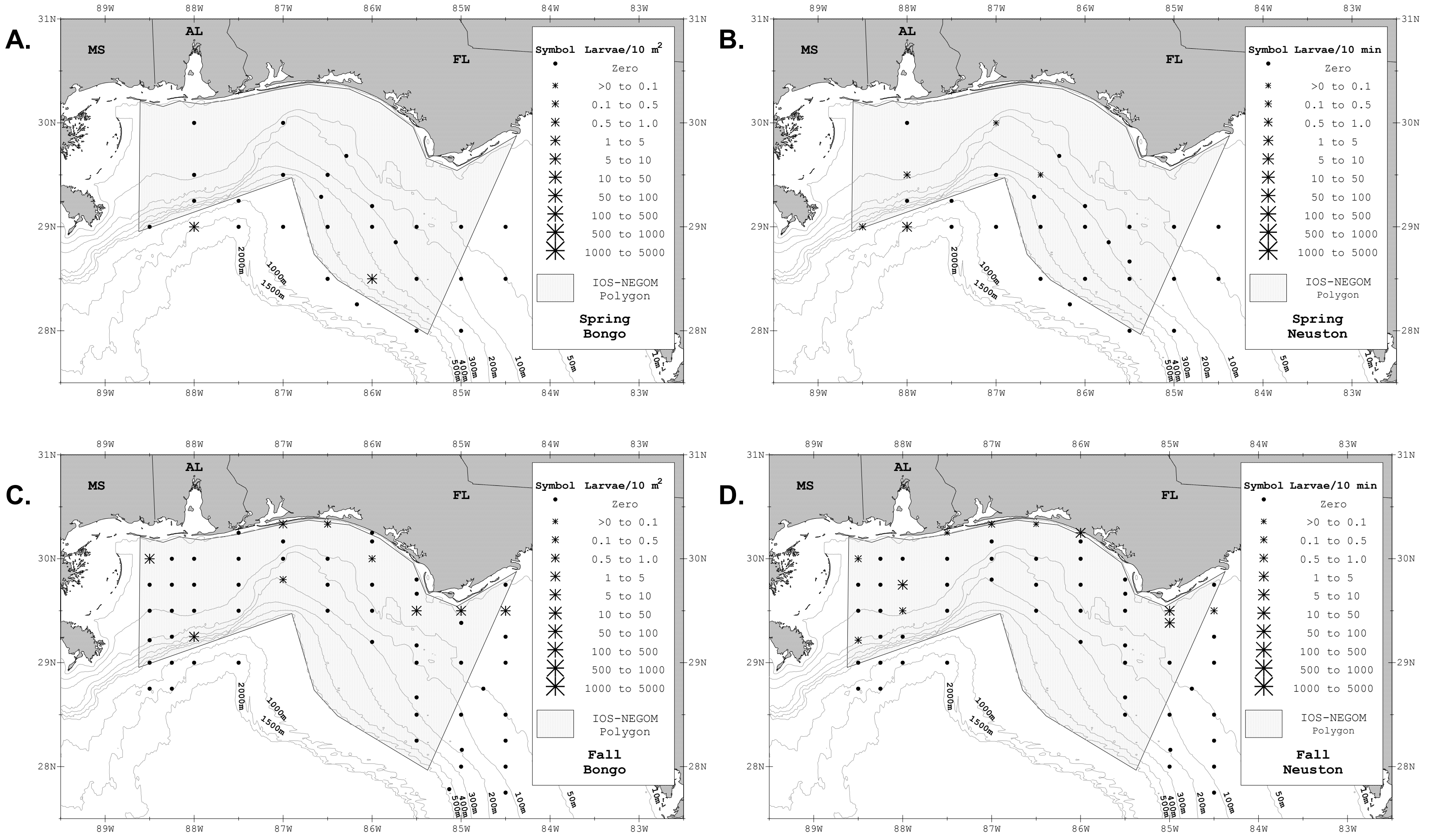


Figure 63. Occurrence and mean abundance of Spanish mackerel, *Scomberomorus maculatus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

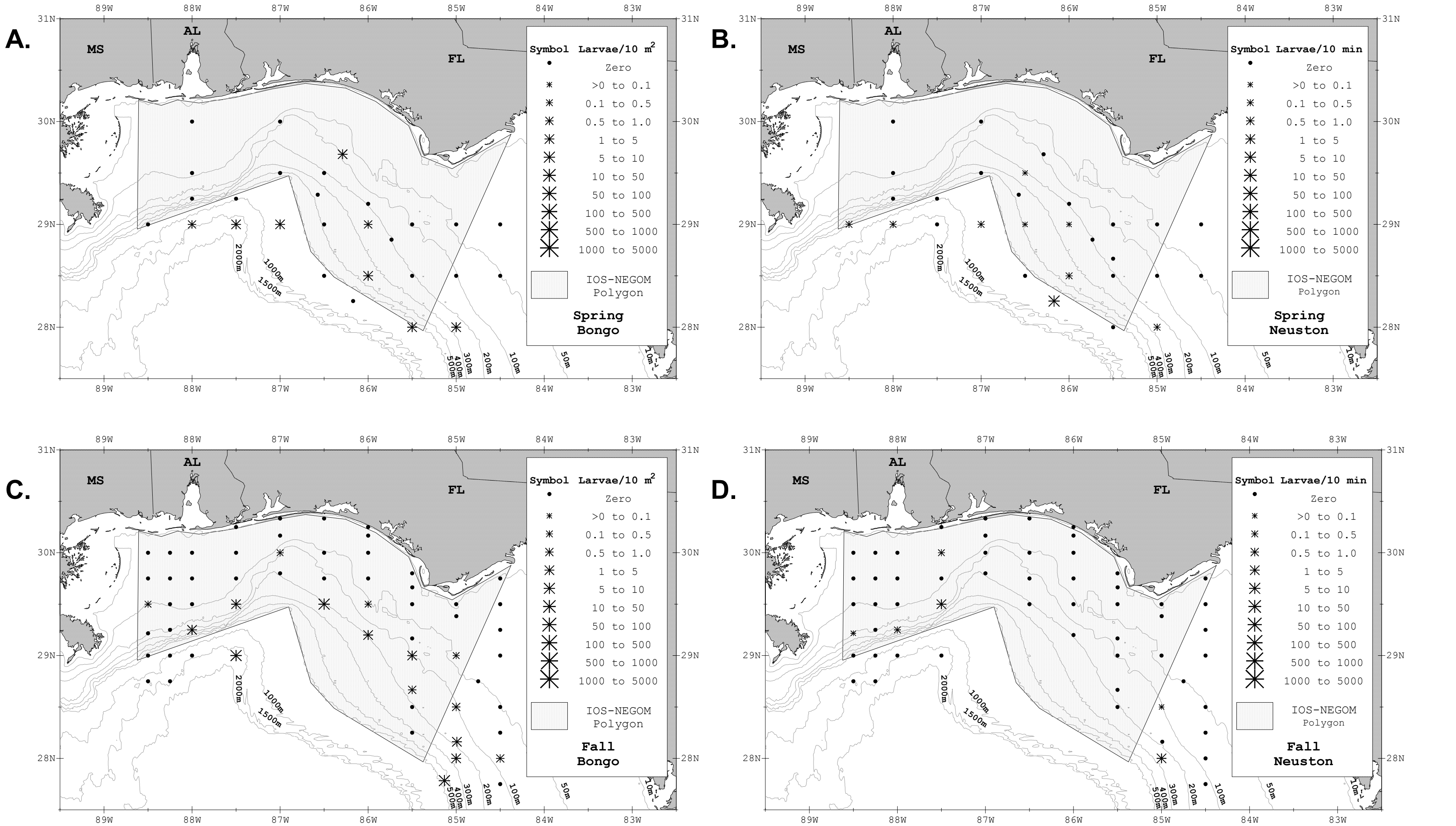


Figure 64. Occurrence and mean abundance of skipjack tuna, *Katsuwonus pelamis*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

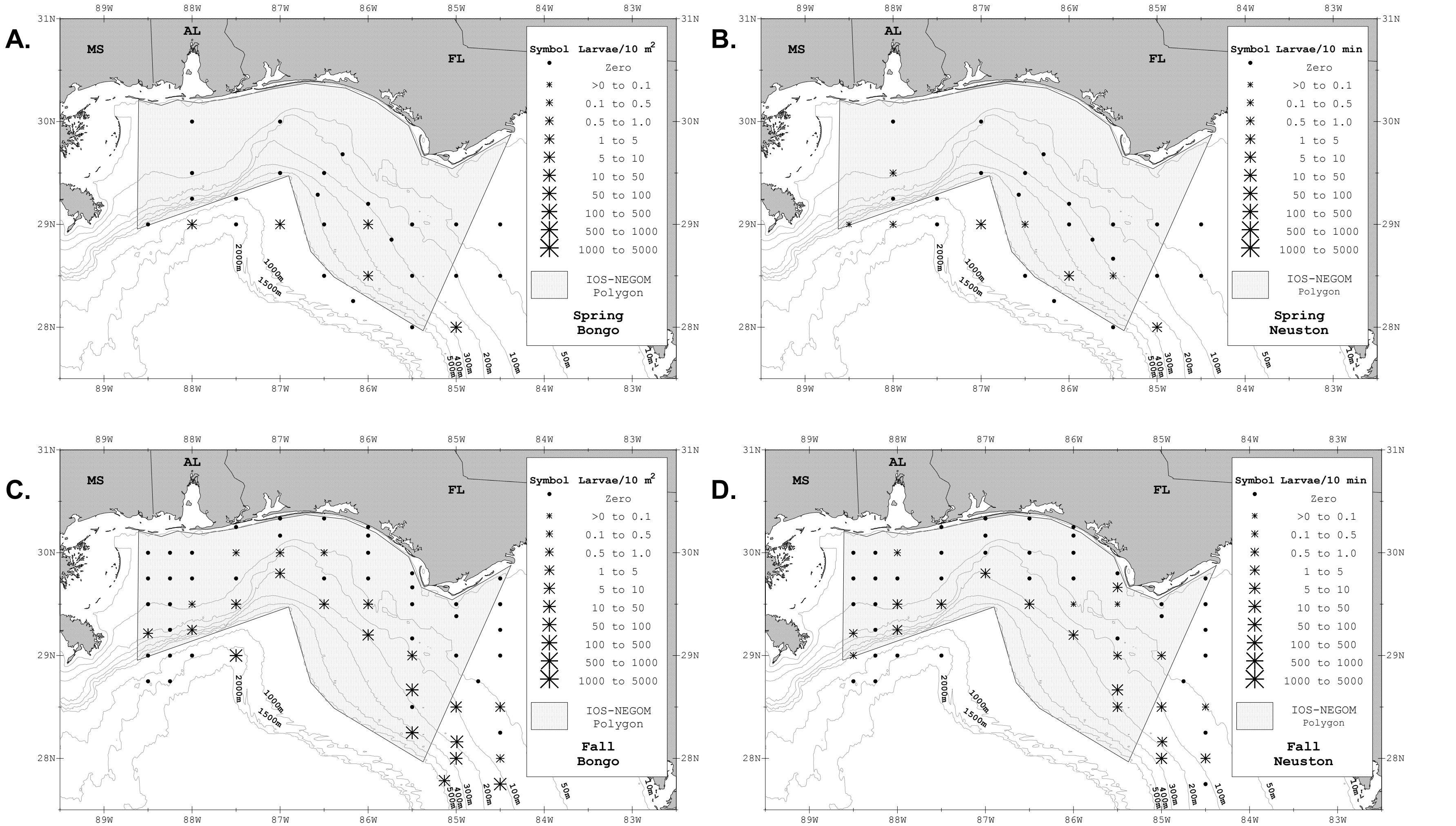
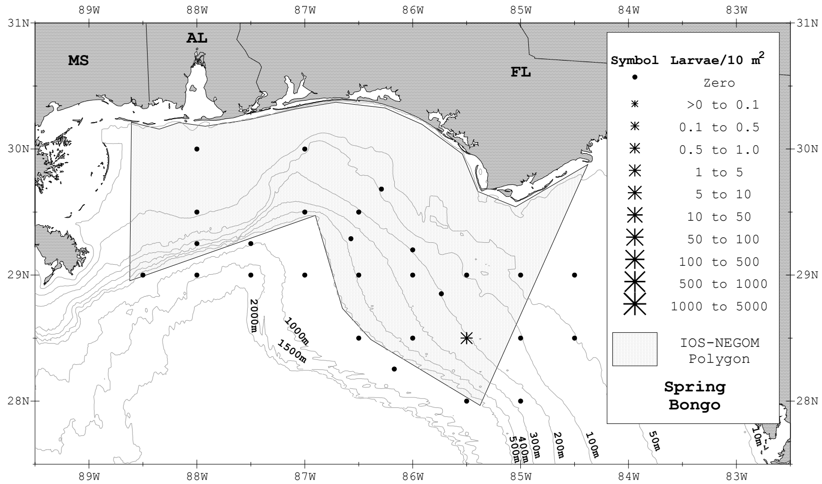
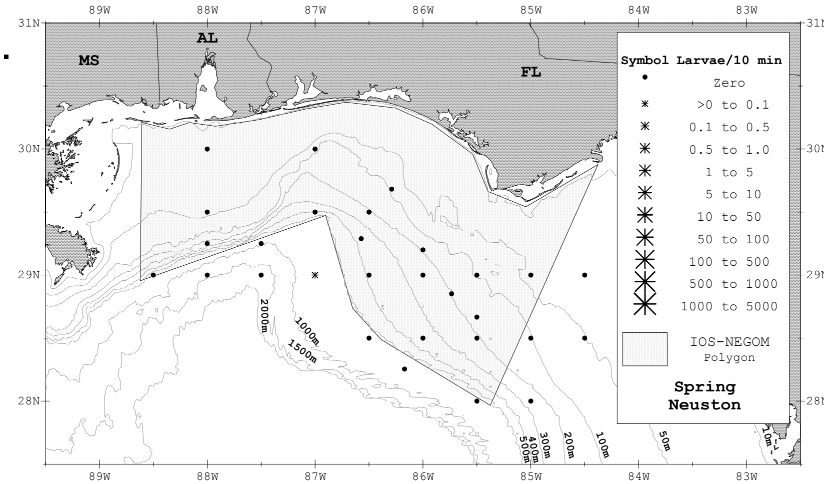


Figure 65. Occurrence and mean abundance of tuna (*Thunnus* spp.) larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.



B.



C.

No Verified Occurrences

Fall
Bongo

D.

No Verified Occurrences

Fall
Neuston

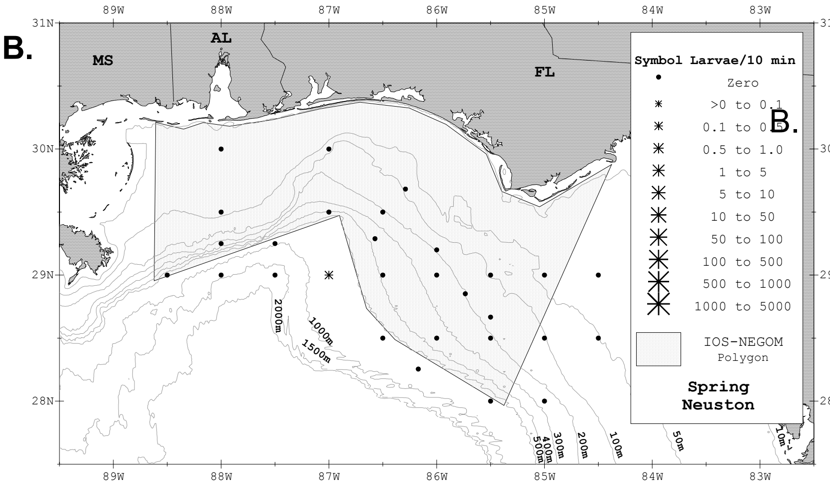
Figure 66. Occurrence and mean abundance of yellowfin tuna, *Thunnus albacares*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

A.

No Occurrences

Spring
Bongo

B.



C.

No Verified Occurrences

Fall
Bongo

D.

No Verified Occurrences

Fall
Neuston

Figure 67. Occurrence and mean abundance of blackfin tuna, *Thunnus atlanticus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

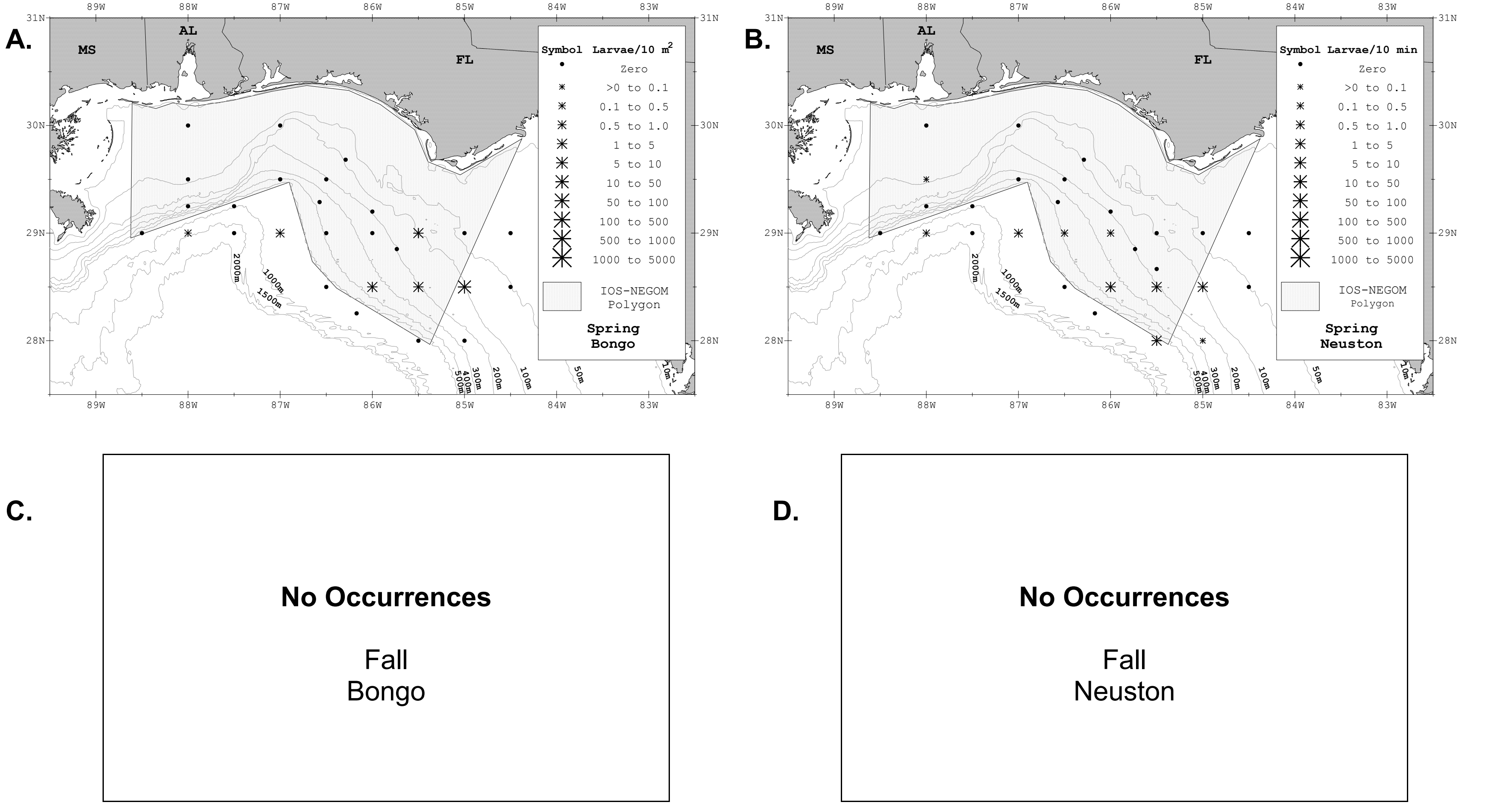


Figure 68. Occurrence and mean abundance of bluefin tuna, *Thunnus thynnus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

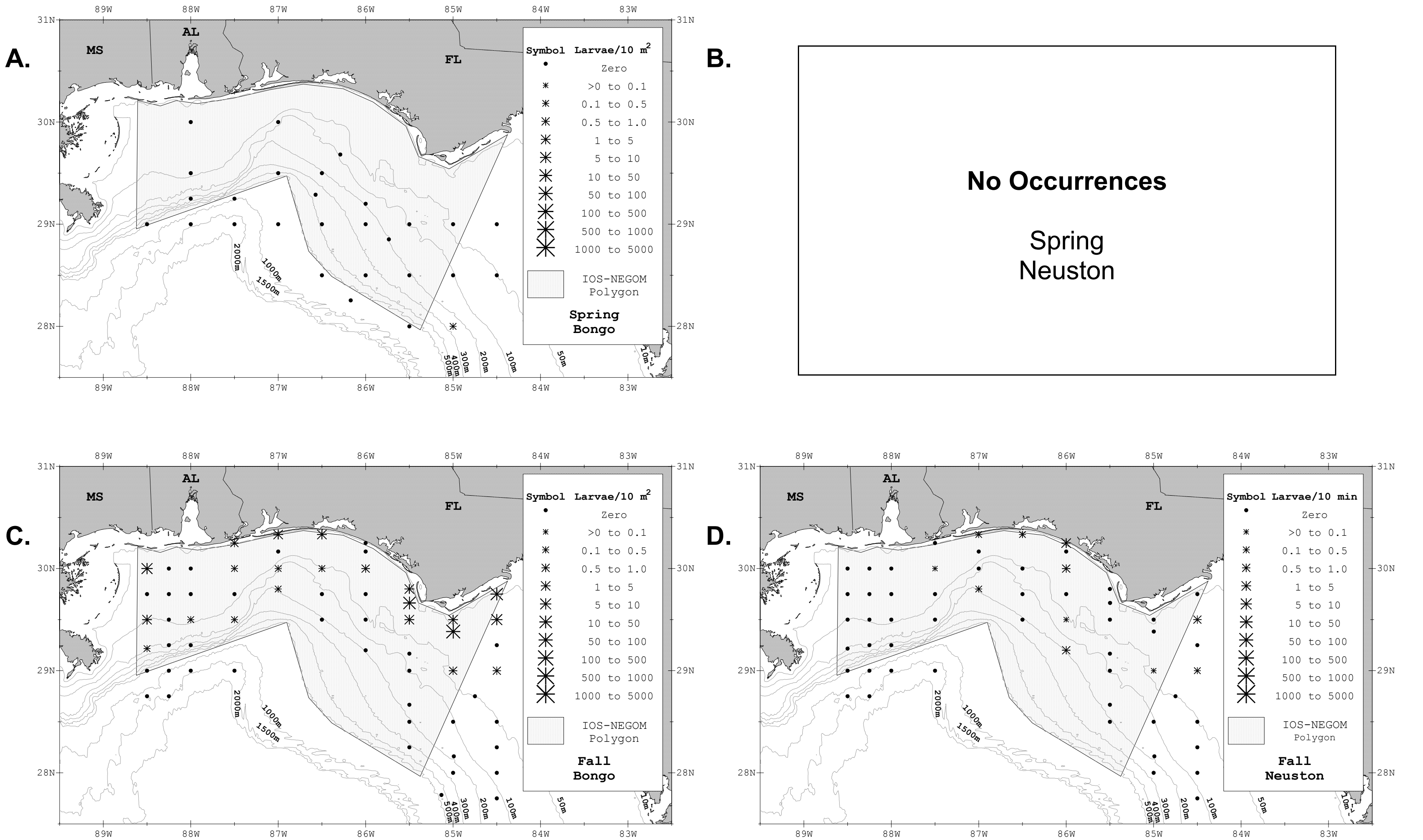


Figure 69. Occurrence and mean abundance of harvestfish, *Peprilus alepidotus*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

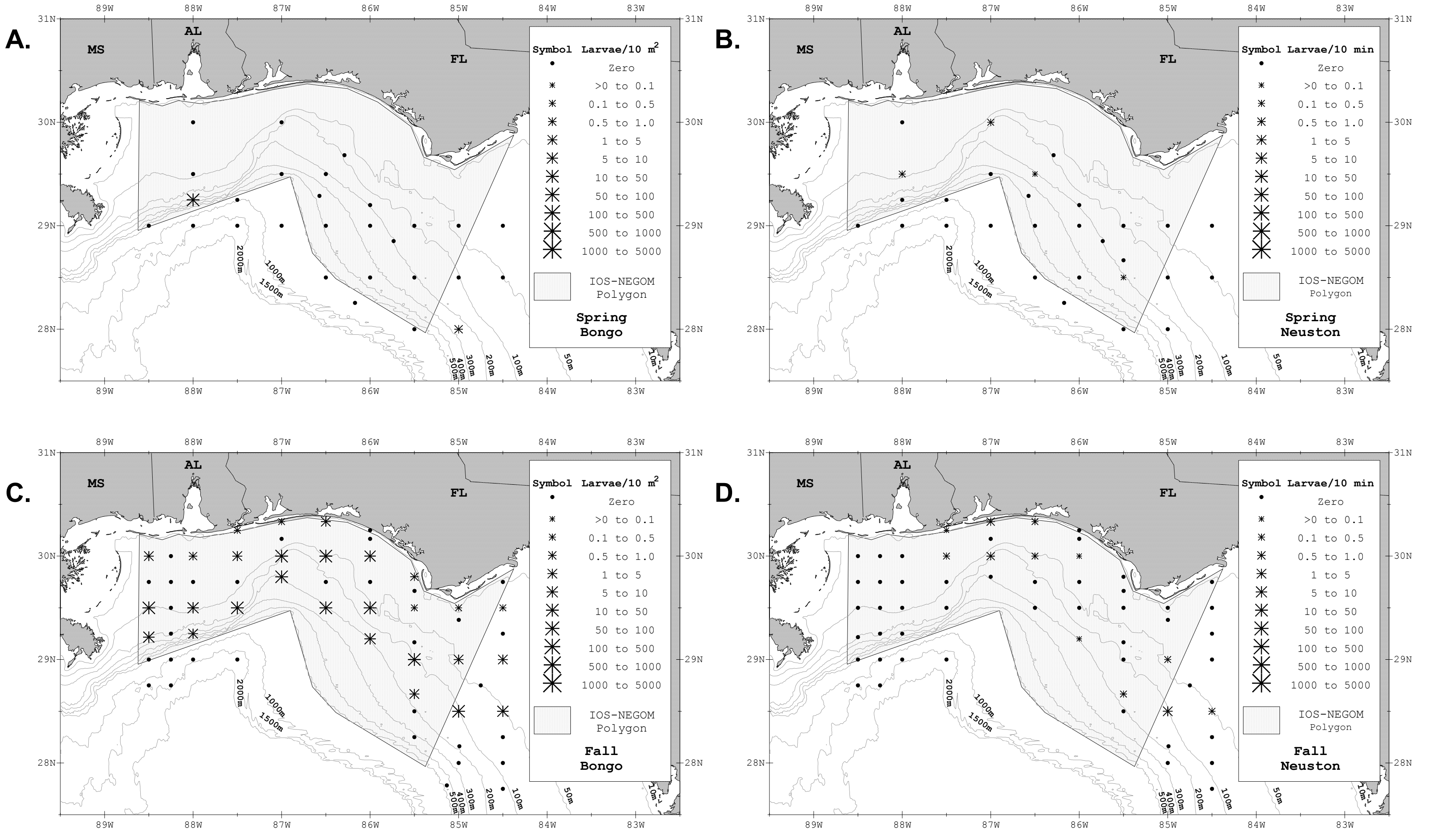


Figure 70. Occurrence and mean abundance of Gulf butterfish, *Peprilus burti*, larvae at localities in the UNIS Study Area captured during SEAMAP surveys, 1982-1999.

Chronological List of NEGOM OCS Ecosystem Studies Publications From the USGS Coastal Ecology & Conservation Research Group

Weaver, D. C., K. J. Sulak, W. Smith-Vaniz, and S. W. Ross. 1999. Community structure and trophic relationships of demersal reef fishes of the Mississippi-Alabama outer continental shelf. Pp. 286-292, In: Proceedings Seventeenth Gulf of Mexico Information Transfer Meeting, Kenner, LA, December 1997, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, OCS Study MMS 99-0042 (M. McKay and J. Nides, eds.).

Gardner, J. V., K. J. Sulak, P. Dartnell, L. Hellequin, B. Calder, and L. A. Mayer. 2000. The bathymetry and acoustic backscatter of the Pinnacles area, northern Gulf of Mexico. U.S. Geological Survey Open-File Report 2000-350, 35 pp.

Weaver, D. C., and K. J. Sulak. 2000. Trophic subsidies in the twilight zone: Food web structure of deep reef fishes along the Mississippi-Alabama outer continental shelf. Pp. 203-208, In: Proceedings: Eighteenth Gulf of Mexico Information Transfer Meeting, Kenner, LA, December 1998, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, OCS Study MMS 2000-030 (M. McKay and J. Nides, eds.).

Gardner, J. V., P. Dartnell, K. J. Sulak, B. Calder, and L. Hellequin. 2001a. Physiography and late Quaternary-Holocene Processes of northeastern Gulf of Mexico outer continental shelf off Mississippi and Alabama. Gulf of Mexico Science 2001(2):132-157.

Gardner, J. V., L. A. Mayer, J. E. Hughes Clarke, P. Dartnell, and K. J. Sulak. 2001b. The bathymetry and acoustic backscatter of the mid shelf and upper slope off Panama City, Florida, northeastern Gulf of Mexico. Cruise Report, RV *Moana Wave*, Cruise M1-01-GM, September 3, through October 12, 2001. U.S. Geological Survey Open-File Report 2001-448, 60 pp.

Gardner, J. V., P. Dartnell, and K. J. Sulak. 2002a. Multibeam mapping of the West Florida Shelf, Gulf of Mexico. U.S. Geological Survey Open-File Report OF02-5, CD-ROM; online at: http://geopubs.wr.usgs. gov/openfile/of02-5.

Gardner, J. V., P. Dartnell, and K. J. Sulak. 2002b. Multibeam mapping of the Pinnacles Region, Gulf of Mexico. U.S. Geological Survey Open-File Report OF02-6, CD-ROM; online at: http://geopubs.wr.usgs.gov/ openfile/OF02-6.

Weaver, D. C. G. D. Dennis III, and. K. J. Sulak. 2002. Community structure and trophic ecology of demersal fishes on the Pinnacles Reef tract. U.S. Department of the Interior, U.G. Geological Survey Biological Sciences Report USGS BSR 2001-0008; Minerals Management Service, OCS Study MMS-2002-034, available in CD-ROM format and online in Adobe® .pdf and .html formats at: http://cars.er.usgs.gov/coastaleco/Tech-Rept-Pinnacles-2002.

Gardner, J. V., J. E. Hughes Clark, L. A. Mayer, and P. Dartnell. 2003. Bathymetry and acoustic backscatter of the mid and outer continental shelf, head of DeSoto Canyon, Northeastern Gulf of Mexico – Data, images, and GIS. USGS Open-File Report OF03-007, CD-ROM; online at: http://geopubs.wr.usgs.gov/ openfile/OF03-007.

Edwards, R. E., and K. J. Sulak. 2003. The potential of deepwater petroleum structures to affect Gulf of Mexico fisheries by acting as fish aggregating devices (FADs) pp. 55-72, IN: (M. McKay and J. Nides, eds.) Proceedings of the twenty-first annual Gulf of Mexico Information

Transfer Meeting, U.S. Department of Interior, Minerals Management Service, New Orleans, LA, MMS OCS Study Report 2003-005 (CD-ROM), January 2002, 748 pp.

Edwards, R. E., and K. J. Sulak. 2003. Overview of fisheries of the deep Gulf of Mexico. pp. 56-63. IN: (W. W. Schroeder and C. F. Wood, eds.) Workshop on Deepwater Environmental Studies Strategies: A Five-Year Follow-Up. U.S. Department of Interior, Minerals Management Service, New Orleans, LA, MMS OCS Study Report 2003-030 (CD-ROM), May 2003, 118 pp.

Lyczkowski-Shultz, J., D. S. Hanisko, K. J. Sulak, and G. D. Dennis, III. 2003. Characterization of ichthyoplankton within the U.S. Geological Survey's Northeastern Gulf of Mexico (NEGOM) Study Area. Based on analysis of Southeast Area Monitoring and Assessment Program (SEAMAP) sampling surveys, 1982-1999. USGS Outer Continental Shelf Ecosystem Studies Program Report, USGS SIR-2004-5059 (CEC NEGOM Program Investigation Report No. 2004-02, April 2004), available in CD-ROM format and online in Adobe® .pdf and .html formats at: http://cars.er.usgs.gov/coastaleco/NEGOM-Ichthyoplankton-Rept.

Thurman, P, R. McBride, G. D. Dennis, III, and K. J. Sulak. 2003. Age and reproduction in three reef-dwelling serranid fishes of the Northeastern Gulf of Mexico Outer Continental Shelf: *Pronotogrammus martinicensis*, *Hemanthias vivanus* & *Serranus phoebe* (with preliminary observations on the Pomacentrid fish, *Chromis enchrysurus*. USGS Outer Continental Shelf Studies Ecosystem Program Report, USGS SIR-2004-xxxx (CEC NEGOM Program Investigation Report No. 2004-03, May 2004), available in CD-ROM format and online in Adobe® .pdf and .html formats at: http://cars.er.usgs.gov/coastaleco/NEGOM-Serranid-Rept-2004.

Brooks, R. A., A. J. Quaid, and K. J. Sulak. Assessment of fish communities associated with offshore sand banks and shoal in the northwestern Gulf of Mexico. USGS Outer Continental Shelf Studies Ecosystem Program Research Cruise Report, February 2004, Cruise USGS-Sabine 2003-01, Sabine Pass, TX, 19-25 July 2003, 20 pp., available in CD-ROM format and online in Adobe® .pdf and .html formats at: http://cars.er.usgs.gov/coastaleco/Cruise-Rept-Sabine-2003-01.

Brooks, R. A., S. S. Bell, C. N. Purdy, and K. J. Sulak. 2004. The benthic community of offshore sand banks: a literature synopsis of the benthic fauna resources in potential MMS OCS sand barrow areas. USGS Outer Continental Shelf Studies Ecosystem Program Report USGS Report SIR-2004-xxxx (CEC NEGOM Program Investigation Report No. 2004-01, February 2004); Minerals Management Service, OCS Study MMS-2004-xxxx, available in CD-ROM format and online in Adobe® .pdf and .html formats at: http://cars.er.usgs.gov/coastaleco/Sandbank-Benthos-Rept-2004.

Other Publications Resulting in Part From NEGOM OCS Research Undertaken by the USGS Coastal Ecology & Conservation Research Group

Stevens, P. W., C. K. Bennett, and J. J. Berg. 2003. Flyingfish spawning (*Parexocoetus brachypterus*) in the northeastern Gulf of Mexico. Environmental Biology of Fishes 67:71-76.

Quattrini, A. M., S. W. Ross, K. J. Sulak, A. M. Necaise, T. L. Casazza, and G. D. Dennis. 2004. Marine fishes new to continental United States waters, North Carolina, and the Gulf of Mexico. Southeastern Naturalist (In Press).

Caruso, J., S. W. Ross, and K. J. Sulak (submitted 2004). New records of deep-water lophiids from off the southeastern U.S. submitted to Bulletin of Marine Science.

CEC Logo Design: Jana M. Miller, Visual Graphics Specialist, USGS

Coastal Ecology and Conservation Research Group
Center for Aquatic Resource Studies
U.S. Geological Survey
7920 NW 71st St.,Gainesville, Florida 32653, USA
352-264-3500; email ken_sulak@usgs.gov